REPORT

OF THE

COMMITTEE

ON

FODDER AND GRASSES

NATIONAL WASTELANDS DEVELOPMENT BOARD
Ministry of Environment and Forests
Government of India
Paryavaran Bhavan, C.G.O. Complex, New Delhi-110003

CONTENTS

1. INTRODUCTION

1.1 India has a very large livestock population as it accounts for about 15 per cent of the total livestock population of the world and only about 2 per cent of the total world's geographical area. The livestock constitutes a very important component of the rural economy and the size of the herd maintained generally indicates the social status of a person in the village. The agriculture in our country is also very much dependent on livestock for manure and for draught power. The total production of dung in the country is estimated at 1,200 million tonnes. The animal draught power accounts for the major portion of the total power utilised in agriculture in India. Besides these very important contributions in agriculture, the livestock provides, milk and milk products, meat, hides, bones, etc. The contribution of the animal husbandry to rural economy is important.

1.2 Even though the importance of livestock in the economy of the farmers needs no emphasis, the desirability of having such a big livestock population as is being maintained is debatable particularly when the quality of the majority of the livestock is very poor. In some areas, the average milk yield of a cow is as low as one litre per day. Poor breed and under nourishment of the livestock explain for such low productivity. The economic return from such a poor livestock is very small while the damage caused by such large livestock population to the vegetative cover and environment is very serious.

1.3 The fodder produced in the country is insufficient to meet the fodder requirement of the livestock. Further, most of the fodder produced and consumed is of poor nutritive value. The livestock in the country is consequently underfed. To compensate for the fall in productivity as a result of malnutrition the farmers generally resort to maintaining big herds of livestock and this increases the pressure on already limited fodder resources and ultimately in the under-feeding of the livestock. This vicious circle can be broken only by increasing fodder production and by improving the quality of livestock.

1.4 With the increasing emphasis on food production, the possibility of increasing fodder production from agricultural lands is very much limited. Fodder production will, therefore, have to be taken up on areas outside agriculture. Extensive wastelands available in the country offer a great potential for fodder production.

1.5 Realising the potential of wastelands for fodder production, the Government of India decided to launch an ambitious programme of wasteland development. The National Wastelands Development Board constituted a Committee to study the present gap in supply and demand, future projections, issues relating to fodder production from wastelands, etc. The composition of the Committee as notified in Office Memorandum No. 7 (12)85-NWDB, dated 1.8.1985, and as subsequently amended is given in Annexure 1.

1.6 The Committee held its first meeting on 20.9.1985 and decided about the broad approach and outline for the collection of the data. The information collected and compiled was subsequently discussed in subsequent two meetings of the Committee. The draft report of the Committee was considered in the meeting on 24.11.1986 and 18.12.1986 and was approved.

1.7 The Committee would like to place on record its gratitude to various Government departments/organisations and the officers who supplied the relevant information and helped in its compilation and presentation.

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II. LIVESTOCK POPULATION

2.1 India is basically an agricultural country and more than 70 per cent of population lives in the villages depending mainly on agriculture and animal husbandry for their livelihood. Livestock is an important component of the economy of the people in the villages. Besides providing milk and meat, livestock is the most important source of draught power for agriculture. The livestock population in the country has increased from *292.02 million in 1951 to 415.94 million in 1982 as is evident from Table 1.*

Table 1

Livestock Population (million) 1951-1982

Category of Livestock	Livestock population in different years						
	1951	1956	1961	1966	1972	1977	1982
Cattle	155.30	158.65	175.56	176.18	178.34	180.14	190.79
Buffaloes	43.35	44.92	51.21	52.95	57.43	62.03	69.00+
Sheep	38.43	39.25	40.02	42.02	39.99	40.91	48.07
Goats	47.08	55.41	60.86	64.59	67.52	75.62	94.72+
Horses & ponies	1.51	1.48	1.33	1.15	0.94	0.91	0.93-
Pigs	4.42	4.93	5.18	5.04	6.90	7.65	9.58+
Camels	0.63	0.78	0.90	1.03	1.11	1.07	1.03
Other Livestock	1.30	1.10	1.15	1.15	1.11	1.21	1.82
Total	292.02	306.52	336.21	344.11	353.34	369.54	415.94

Source : Livestock Census Reports.

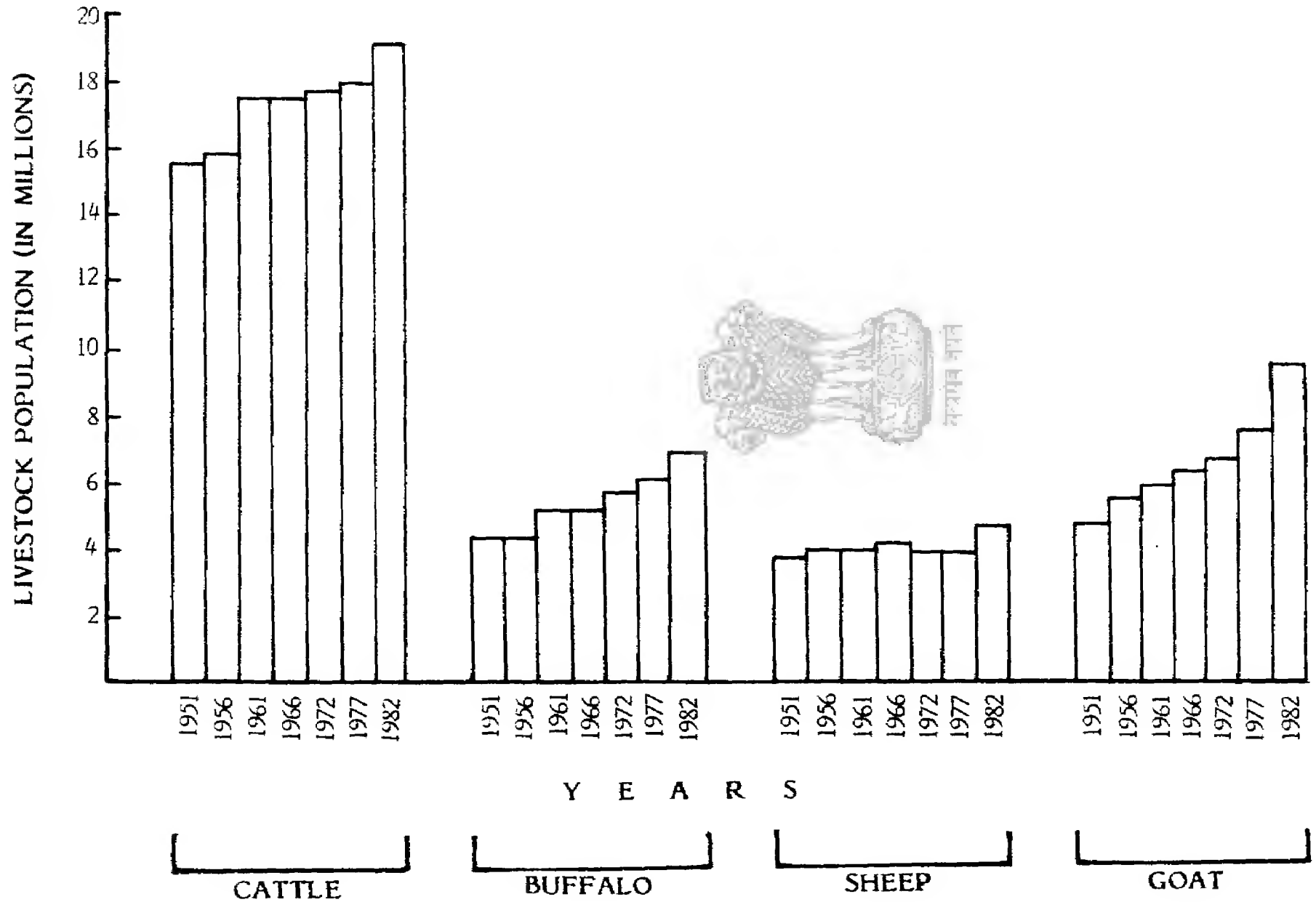
2.2 Even though the population of all the categories of livestock increased during this period, the magnitude of increase differed with the category; the percentage increase of the population in 1982 as compared to 1951 was maximum in the case of goats followed by buffaloes, sheep and cattle in descending order. The trends of the increase or decrease of population are presented in table 2 and figure 1.

Table 2

Growth pattern of livestock population (1951-1982)

Category of Livestock	Percentage increase in 1961 over 1951	Percentage increase or decrease in 1972 over 1961	Percentage increase in 1982 over 1972
Cattle	+13.04	+1.58	+6.98
Buffalo	+18.13	+12.15	+20.15
Sheep	+4.14	-0.001	+20.20
Goat	+29.27	+10.94	+40 28

FIG.1. LIVESTOCK POPULATION IN INDIA (1951–1982)



2.3. The livestock population has continuously increased during the period 1951-1982 except for sheep during the period 1961-72. The rate of increase was, however, lower during 1961-72 than during the preceding and succeeding periods. Among the categories of livestock, the highest increase during the period 1972-82 has been recorded in case of goats followed by sheep, buffalo and cattle in descending order. High rate of increase in livestock population during the period 1972-82 as compared to the preceding 10 yearly period is very disquietening. The general belief that the religious sentiments in favour of cow are responsible for large population of livestock in the country is not supported by the trend of increase in livestock population. The population of cattle has been increasing at a much lower rate than that of goats, buffaloes and sheep except for sheep during 1951-72 period. Further, the increase has been more in case of bullocks than in the number of cows. The rapid increase in the population of goats and sheep during 1972 and 1982 may be because they are more efficient users of the poor type of roughage available than the buffaloes and cows. The higher rate of increase in case of buffaloes is because of the higher milk yield and consequently higher economic returns from a buffalo than from a cow. The market acceptability of buffalo milk is also higher than that of cow milk because of the higher fat content in the former. As a result of the higher economic returns from a buffalo, the increase in case of buffaloes in milk during the period 1951-57 has been 65.99 per cent as compared to 22.31 per cent in case of cows in milk during the corresponding period. During the period 1961-1977, the population of she-buffaloes increased by 25 per cent and that of cows by 6 per cent; the ratio of cow to buffalo in milk and to total population decreased from 1.65 to 1.37 and from 2.16 to 1.83 respectively during this period (Table 3). As a buffalo is heavier in body weight than a cow, this shift has resulted in an increased demand for feed and fodder.

Table 3

Composition of milch herd (million)

	Category	Year			
		1961	1966	1972	1977
A.	Cattle (million)				
	(i) In milk	20.66	20.97	22.03	23.18
	(ii) Dry	25.01	25.80	26.33	26.59
	(iii) Total She-cattle	54.20	54.72	56.40	57.59
B.	Buffalo (millions)				
	(i) In milk	12.46	12.92	15.07	16.96
	(ii) Dry	9.49	10.44	11.30	11.92
	(iii) Total She-buffaloes	25.02	26.16	29.24	31.86
C.	Animals in milk as per-cent of total adult females				
	(i) Cow	38.1	38.3	39.1	40.25
	(ii) She-buffalo	49.8	49.3	51.1	53.23
D.	Ratio of cow to she-buffalo				
	(i) In milk	1.65	1.62	1.46	1.37
	(ii) Total	2.16	2.09	1.92	1.83

Source : Livestock census reports.

Livestock Population in Different States

2.4 The livestock population in the country in 1982 in different States/Union Territories is presented in Table 4. The census figures of 1982 were not available for Manipur, Punjab and Arunachal Pradesh and 1977 census figures have been taken for these States/UTs.

Table 4

Livestock Population, 1982

(in thousand)

State/U.Ts.	Cattle	Buffa-loes	Sheep	Goats	Horses & ponies	Pigs	Camels	Other live-* stock	Total
1	2	3	4	5	6	7	8	9	10
States									
Andhra Pradesh	13117	8724	7507	5534	13	786	@	55	35736
Assam	6750	558	46	1729	16	578	—	@	9677
Bihar	16359	4622	1337	12297	107	1447	@	41	36210
Gujarat	6929	4436	2357	3266	24	165	74	101	17352
Haryana	2342	3369	758	608	29	250	121	85	7562
Himachal Pradesh	2174	616	1090	1060	17	8	1	23	4989
J & K	2312	555	1861	949	124	2	3	11	5817
Karnataka	10718	3610	4615	4449	22	327	@	54	23795
Kerala	3097	409	7	2004	@	127	@	—	5644
Madhya Pradesh	26982	6415	958	7582	112	477	16	58	42600
Maharashtra	15937	3958	2570	7517	49	274	1	60	30366
Manipur	294	52	2	16	1	—	—	142	507
Meghalaya	550	29	26	186	8	206	—	12	1017
Nagaland	151	9	@	62	@	248	—	11	481
Orissa	12930	1333	1990	4931	1	418	—	@	21603
Punjab	3312	4110	498	722	76	—	—	279	8997
Rajasthan	13466	6035	13389	15398	45	179	753	210	49475
Sikkim	172	4	11	96	1	30	—	3	317
Tamil Nadu	10247	3207	5475	5111	8	667	@	78	24793
Tripura	680	16	5	343	2	104	—	@	1150
Uttar Pradesh	26048	15663	2334	9690	247	2249	56	282	56569
West Bengal	15649	986	1200	10918	21	770	@	@	29544
Union Territories									
A & N Islands	36	12	—	34	—	96	—	—	178
Arunachal Pradesh	168	12	20	76	—	—	—	307	583
Chandigarh	6	19	1	1	@	2	—	1	30
D & N Haveli	44	4	1	14	@	@	—	@	63
Delhi	51	176	3	14	3	22	@	4	273
Goa, Daman & Diu	130	44	1	27	@	72	—	@	274
Lakshadweep	2	—	—	10	—	—	—	—	13
Mizoram	48	4	1	28	1	77	—	1	160
Pondicherry	93	9	9	53	@	3	—	@	167

Source : Thirteenth census of Livestock and Farm Equipment (Provisional results) 1982, Directorate of Economics and Statistics, Ministry of Agriculture.

@Less than 500.

*Other livestock includes Donkeys, Mules & Yaks.

2.5 The States having large livestock population are Uttar Pradesh, Rajasthan, Madhya Pradesh, Bihar, Andhra Pradesh, West Bengal, Maharashtra, Tamil Nadu, Karnataka, Orissa, Gujarat, and Assam. These 12 States account for 81.44 per cent of the geographical area of the country and 90.44 per cent of the total livestock population. Large sheep and goat population is maintained in the States of Rajasthan, Andhra Pradesh, Tamil Nadu, Gujarat, Karnataka, Uttar Pradesh, Orissa, Himachal Pradesh, Jammu & Kashmir, West Bengal and Madhya Pradesh. These States have 78.20 per cent of the sheep and goat population of the country. The sheep and goats are thus reared mainly in dry tracts and hilly regions of the country producing poor roughage fodder. The cattle population is largely concentrated in Madhya Pradesh, Uttar Pradesh, Bihar, Rajasthan, Andhra Pradesh, Orissa, Karnataka, West Bengal, Tamil Nadu, Maharashtra, Assam and Gujarat. Buffalo population is large in Uttar Pradesh, Andhra Pradesh, Madhya Pradesh, Rajasthan, Bihar, Gujarat, Karnataka, Maharashtra and Haryana.

2.6 Table 5 presents a comparison of population of cattle, buffaloes, sheep and goats in different States/Union Territories in 1961 and 1982.

Table 5

Livestock Population in 1961 and 1982

State/Union Territory	1961			1982		
	Cattle	Buffaloes	Sheep & Goats	Cattle	Buffalow	Sheep & Goats
Andhra Pradesh	12345	6949	8363	13117	8724	13041
Assam	6488	583	54	6750	558	1775
Bihar	16104	3698	1156	16359	4622	13634
Gujarat	6557	2917	1481	6929	4436	5623
Haryana*	—	—	—	2342	3369	1366
Himachal Pradesh*	1213	208	662	2174	616	2150
J & K	1841	401	1163	2312	555	2810
Karnataka	9673	3026	4765	10718	3610	9064
Kerala	2753	485	24	3097	409	2004
Madhya Pradesh	24774	5576	1009	26982	6415	8540
Maharashtra	15328	3087	2093	15937	3958	10087
Manipur	293	55	4	294	52	18
Meghalaya	N.A.	N.A.	—	550	29	212
Nagaland	N.A.	N.A.	—	151	9	62
Orissa	9810	1075	994	12930	1333	6921
Punjab*	6059	4425	925	3312	4110	1220
Rajasthan	13136	4019	7360	13466	6035	28787
Tamil Nadu	10826	2594	7160	10247	3207	10586
Tripura	495	43	3	680	16	348
Uttar Pradesh	26284	10976	2462	26048	15663	12024
West Bengal	11476	986	535	15649	986	12118
Union Territories	102**	108**	10	410@	268@	197@
Total	175557	51211	40223	190454	68422	142587

Source : Indian Livestock Census, 1961 and 1982.

* Pre-reorganisation population.

** Includes figures for A & N Islands, Lakshadweep & Delhi only.

@ Includes figures for Goa, Dadar & Nagar Haveli, Chandigarh, Mizoram, A&N Islands, Lakshadweep, Pondicherry and Delhi*.

2.7 During this period (1961-82), the cattle population increased by 30-50 per cent in Tripura, West Bengal, and Orissa, by 20-30 per cent in Jammu & Kashmir and Kerala and by 20 per cent or less in the remaining States. The number of buffaloes increased by 50 per cent in Gujarat and Rajasthan. The States registering an increase of 25-50 per cent in buffalo population are Uttar Pradesh, Jammu & Kashmir, Maharashtra, Andhra Pradesh and Bihar. The population of sheep and goats increased by 2 to 4 times in most of the States except Karnataka and Andhra Pradesh in which the increase was 90 and 56 per cent, respectively.

Density of Livestock Population

2.8 The livestock population density on the basis of 1982 population per hectare of cropped area (1980-81) and per hectare of geographical area are presented in Table 6. The number of livestock units per capita are also presented in this table. As the fodder requirement varies with the type of livestock, the density on the basis of total livestock population does not present a correct picture. The livestock population for this purpose has, therefore, been converted into *livestock units* taking each sheep, goat, donkey, cattle, horse, camel and buffalo as 1, 1.5, 3, 4, 4, 5 and 6 units respectively.

2.9 The density in terms of livestock units per hectare of cropped area varies from 4.75 in Nagaland to 16.80 in Jammu & Kashmir. The density on the basis of geographical area varies from 0.69 in Nagaland to 9.74 in West Bengal. On the basis of the average production of cereal crops and the intensity of cropping, *one hectare of cropped*

Table 6

Density of Livestock Population

State	Number of livestock units		
	Per ha of Cropped area	Per ha of Geographical area	Per Capita
Andhra Pradesh	9.83	4.40	0.67
Assam	9.59	4.21	0.49
Bihar	10.17	6.54	0.58
Gujarat	5.77	3.28	0.51
Haryana	5.56	7.12	0.58
Himachal Pradesh	16.00	5.07	1.16
Jammu & Kashmir	16.80	3.50	0.97
Karnataka	7.12	3.99	0.64
Kerala	6.24	4.59	0.22
Madhya Pradesh	7.44	3.60	0.82
Maharashtra	5.01	3.30	0.48
Manipur	6.93	0.69	0.36
Meghalaya	12.16	1.21	0.76
Nagaland	4.75	0.69	0.62
Orissa	7.90	4.45	0.82
Punjab	5.88	7.91	0.54
Rajasthan	7.31	3.70	1.44
Sikkim	9.57	1.21	1 00
Tamil Nadu	11.35	5.65	0.51
Tripura	8.92	3.19	0.56
Uttar Pradesh	8.80	7.27	0.51
West Bengal	11.31	9.74	0 54

area cannot normally support more than about 3 livestock units per year in *rainfed areas and about 6 livestock unit in irrigated areas.* In states where the density of livestock units per hectare exceeds these figures, the fodder requirement of the livestock cannot be met only from the cropped area alone and will have to be supplemented by other sources outside agriculture. Most of the States fall in this category. Statewise analysis of the self-sufficiency in fodder production becomes difficult because of the migration of livestock from one state to another.

2.10 The number of livestock units per capita varies from 0.22 in Kerala to 1.44 in Rajasthan; in most of the States the number of livestock units per capita varies from *0.5 to 0.7.* Efforts need be made to reduce livestock population per capita particularly in ecologically frgile areas such as Himachal Pradesh, Jammu, & Kashmir, Rajasthan and Sikkim. The measures to be taken to reduce the livestock population may include effective extension programme to convince the farmers to maintain livestock of improved breeds, to reduce the number of poor quality livestock, to undertake castration of poor quality bulls, etc. The Committee endorses the recommendations of the Committee for Review of Rights in the Forest Areas of India* that about five scrub cattle may be exchanged with one cross-bred cow and that gosadans may be established/strengthened to keep the scrub cattle received in exchange. This programme of exchanging scrub cattle with cross-breed cows should first be tried in areas where there is assumed market for the sale of milk.

*Report of the Committee for Review of Rights and Concessions in the Forest Areas of India, Govt. of India, Ministry of Agriculture, Forestry Division, 1984.

III. FODDER REQUIREMENT

Assessment of Fodder Requirement

3.1 Assessment of fodder requirement depends upon a number of factors such as the methods of animal rearing and feeding, density and kind of livestock, socio-economic status of the people, climate etc. The productivity of the livestock mainly depends on the quantity and quality of feed and fodder. The area allocated for fodder production in India is very large. Most of the livestock population is consequently underfed. The programme of livestock improvement cannot succeed if adequate quantity of good quality feed and fodder cannot be assured. The Famine Enquiry Commission (1945) stressed that "feeding is of crucial importance, for no lasting improvement could be brought about by breeding alone, since improved breeds deteriorate rapidly if not fed adequately".

3.2 The major fodder resources of the country are *grass* and *grazing, agricultural crop residues*, *cultivated fodders*, edible weeds from cropped lands and *leaf fodder from trees*. The amount of fodder obtained through grazing varies from one region to another and depends on the extent of forest areas and grazing lands available and their proximity to habitations. In hilly tracts and richly forested areas, most of the livestock is taken out for grazing. In Himachal Pradesh, 97 per cent of sheep and goats, 83 per cent of cows and 11 per cent of buffaloes are taken to the forest areas for grazing. In the Punjab and Haryana and other similarly agriculturally developed regions, on the other hand, the proportion of livestock maintained on grazing is very small.

3.3 Various estimates of the requirements of feed and fodder for different categories of livestock have been made in the past. Separate feeding schedules have been taken into account for calculating the *feed requirements of livestock*. The estimates made consequently varied widely. The joint committee of the Nutritional Advisory Committee of the Indian Council of Medical Research and the Animal Nutrition Committee of the Indian Council of Agricultural Research (ICAR) estimated the requirement of straw/*kadbi*, green fodder and green grass from grazing as 190, 189, and 453 million tonnes as against the availability of 130, 111 and 527 million tonnes respectively basing their calculations on 1951 livestock census. Based on 1956 livestock census, sub-committee to the *Central Council of Gosamvardhana* estimated the requirement of 168 million tonnes of straw/*kadbi*, 290 million tonnes of green fodder and 288 million tonnes of green grass from grazing as against the availability of 142, 132 and 288 million tonnes respectively. The estimates made both in 1951 and 1956 showed shortage of straw/*kadbi* and grass fodder.

3.4 Reviewing the requirement of fodder, the Committee on Livestock Feed and Fodder, Ministry of Agriculture* estimated in 1974 the requirement based on the projected

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*Committee on Livestock Feed & Fodder, Ministry of Agriculture, Govt. of India, 1954.

livestock population for the year 1973-74 (240.80) and also for 1978-79 (249.96 millions) and the same is given in Table 7.

Table 7

Estimated Requirement of Feed and Fodder

Feed and Fodder	Requirement (million tonnes)	
	1973-74	1978-79
Dry fodder	339.565	353.480
Green fodder	340.370	387.560
Concentrates	17.475	22.295

3.5 The National Commission on Agriculture (NCA), 1976,* adopted the average rates of feeding the concentrates, green and dry fodder for different categories of livestock as summarised in table 8.

Table 8

Average Rates of Feeding the Livestock

Category of livestock	Rates of feeding per day		
	Concentrates	Green fodder	Dry fodder
(A) *Cattle*			
(1) Crossbred (milch)	2.75	20.00	6.00
(2) Females over 3 years			
(i) Improved cows (milch)	1.20	10.00	6.00
(ii) Other milch cows and not calved even once	0.125	3.50	3.16
(3) Males over 3 years of age	0.17	4.96	5.65
(4) Less than 3 years of age			
(i) Crossbred (young stock)	1.50	10.00	2.00
(ii) Other young stock	0.016	1.58	1.47
(B) *Buffaloes*			
(1) Female over 3 years of age			
(i) Improved buffaloes	1.50	10.00	6.00
(ii) Other milch buffaloes and those not calved even once	0.41	5.72	5.08
(2) Males over 3 years of age	0.109	6.51	5.43
(3) Less than 3 years of age	0.01	1.59	1.64
(C) *Other Livestock*			
(i) Improved sheep	0.274	—	0.40
(ii) Horses & ponies	0.50	—	—

*Report of the National Commission on Agriculture (NCA), 1976, Part VII, Animal Husbandry, Ministry of Agriculture, Govt. of India, New Delhi.

3.6 On the basis of above rates of feeding, the National Commission on Agriculture (1976) gave the requirement in 1973 for the projected livestock population of 2000 as summarised in Table 9.

Table 9

Requirement of fodder for projected population in 2000

Category of Livestock	Projected population in 2000 (million)	Requirement per head per day (Kg)			Requirement per year for projected population in 2000 (million tonnes)		
		Concentrates	Green fodder	Dry fodder	Concentrates	Green fodder	Dry fodder
(A) *Cattle*							
(i) Males working and breeding	73.04	0.25	5.00	5.50	6.66	133.3	146.7
(ii) Female milch and dry							
(a) Non-descript	21.35	0.20	5.00	4.00	1.56	38.9	31.2
(b) Improved Indigenous	11.00	1.20	10.00	6.00	4.82	39.6	24.1
(c) Cross-bred	18.90	2.75	20.00	6.00	18.97	136.1	41.4
(d) Young stock cross-bred	15.98	1.50	10.00	2.00	8.75	58.3	11.7
Others	26.50	0.50	5.00	1.50	4.84	48.4	14.5
(B) *Buffaloes*							
(i) Males working and breeding	6.98	0.20	5.00	5.00	0.51	12.7	12.7
(ii) Females milch and dry							
(a) Non-descript	12.99	0.50	5.00	5.00	2.37	23.7	23.7
(b) Improved	17.60	1.50	10.00	6.00	9.64	64.3	38.5
(c) Young stock	19.07	0.10	5.00	2.00	0.70	34.8	13.9
Total for bovines					58.82	590.1	358.40
(C) Improved sheep	60.00	0.30	—	0.4	6.57	—	8.8
(D) Improved goats	40.00	0.30	—	0.4	4.38	—	5.8
(E) Horses & ponies	0.8	0.50	—	—	0.15	—	—
(F) Camels	1.0	0.50	—	—	0.18	—	—
Total for others					11.28	—	14.60
GRAND TOTAL					70.10	590.1	373.00

3.7 The fodder requirement for different categories of livestock recommended by National Dairy Research Institute is as summarised in Table 10.

Table 10

Requirement of fodder for different categories of livestock

Category of livestock	Fodder per day (Kg/head)	
	Dry	Green
Male cattle or buffaloes used for breeding and work	8.00	16.00
Male cattle or buffaloes used for work only or in milk	7.00	14.00
Bullocks not used for work, cows in milk, cows used for work, he-buffaloes not used for work and she-buffaloes which are dry	6.00	12.00
Cows which are dry	5.00	10.00
Cattle and buffalo calves 1-3 years age	3.00	3.00
Cattle and buffalo calves below 1 year age	1.00	1.00

3.8 Based on the above rates of feeding, Rajapurohit and Vivekanand (1981)* estimated the requirement of green and dry fodder for different States as summarised in Table 11.

Table 11

Estimated requirement of fodder in differnt States of India (1965-66)

State	Requirement (million tonnes)	
	Dry Fodder	Green Fodder
Andhra Pradesh	37.49	71.51
Assam & Meghalaya	12.65	23.81
Bihar	38.27	72.45
Gujarat	16.94	31.66
Kerala	7.37	13.86
Madhya Pradesh	55.17	100.96
Maharashtra	37.01	70.47
Karnataka	23.68	45.04
Orissa	22.70	—
Punjab*	13.54	25.02
Rajasthan	29.40	54.08
Tamil Nadu	22.46	42.77
Uttar Pradesh	67.25	127.89
West Bengal	27.11	51.55

*Rajapurohit, A.R. and Vivekanand, M. (1981). Bovine feed availability and requirement in India—A district-wise analysis. Agricultural Development and Rural Transformation Unit, Institute for Social and Economic Change, Bangalore.

*Before reorganisation.

3.9 The fodder requirement in the country in 1985 for the cattle and buffaloes on the basis of the economic feeding rate worked out by Shah and co-workers* is presented in Table 12.

3.10 As is evident from the foregoing account, various attempts have been made to assess the fodder requirement in the country.

Table 12

Total fodder consumption (1985) by cattle and buffaloes

Category of livestock	Economic feeding rates (kg/day)			Population (in million)	Total yearly consumption (million tonnes)		
	Dry fodder	Green fodder + Natural herbage	Concentrates		Dry fooder	Green fodder + Natural herbage	Concentrates
Male cattle >3 years	4.5	10.00	0.17	77.58	127.42	283.16	4.81
Female cattle (in milk) >3 years	4.0	10.00	0.52	24.98	36.47	91.17	4.74
Female cattle (dry) >3 years	3.41	4.92	—	27.81	34.65	49.98	—
Young stock Cattle <3 years	1.62	2.59	—	47.34	28.09	44.80	—
Male buffaloes >3 years	5.99	9.35	—	8.09	17.69	27.63	—
Female buffaloes >3 years (in milk)	4.00	13.00	1.00	21.66	21.62	102.77	7.89
Female buffaloes >3 years (dry)	5.12	7.81	—	14.04	26.26	40.03	—
Young stock buffaloes <3 years	1.64	2.44	—	24.44	14.71	21.71	—
National Milch Herd							
(a) Cross-bred in milk	4.60	19.50	2.00	5.31	8.91	37.79	3.88
(b) Cross-bred dry	3.11	10.00	0.77	1.77	2 0	6.46	0.50
(c) Improved buffaloes in milk	4.9	18.00	1.50	2.32	4.15	15.24	1.27
(d) Improved buffaloes dry	3.11	10.00	0.77	0.77	0.87	2.80	0.22
Total					**322.84**	**723.54**	**23.31**

*Shah, T., Tripathi, A K. & Desai, M. 1980. Impact of increased dairy productivity on farmers use of feedstuffs, Economic and Political Weekly, XV (33): 1407-1412.

The standards of feeding adopted for the assessment of feed and fodder requirement in these reports also vary. Further, these estimates of the feed and fodder requirement are not comparable because some of them have been made only for the cattle and buffaloes while others include sheep and goats also.

3.11 The fodder for the livestock is required for maintenance and for productive purposes or work. Maintenance ration has a relation to the age, health and the kind of the livestock. Likewise, the production ration depends on the level of production and the product aimed at. The ration required for the working animals will also vary. It may, therefore, be difficult to work out the ration for livestock in the absence of complete details of the livestock population. The requirement of maintenance ration is generally related to the body weight of the livestock. Normally, the requirement of dry fodder for the livestock is taken to be about 2-3 per cent of the body weight which for the Indian livestock is taken to vary from 200 to 400 Kg for cattle and 400-500 Kg for buffaloes. The body weight of the cattle varies widely in the country. The Committee, therefore, classified the cattle population into three categories, viz., small, medium and big on the basis of body weight which was taken to be 200, 300 and 400 Kg respectively for these categories. The proportion of small, medium and big cattle worked out on the basis of 1982 census figures were applied to the projected population of 1990, 1995 and 2000. Dry fodder requirement for these categories of cattle has been assumed on the basis of body weight mentioned earlier. In case of buffaloes, the average body weight per unit has been taken to be 400 Kg. Four units of sheep/goat are taken to be equal to a cattle unit of body weight 300 Kg. Fodder requirement of a unit of livestock of other categories except pigs has been taken to be equal to that of cattle. The population of pigs has been omitted while calculating fodder requirement.

3.12 The projected population of cattle and buffaloes for 1985, 1990 and 2000 worked out by the Department of Animal Husbandry, Government of India is presented in Table 13.

Table 13

Projected population of cattle and buffaloes

Species	Category	Cumulative growth rate Used for projections	Projected population (million) 1985	1990	2000
Cattle	(i) Crossbred milch	8.0	5.70	8.40	18.00
	(ii) Improved milch	2.8	7.50	7.80	11.30
	(iii) Non-descript milch	0.45	40.77	41.70	43.60
	(iv) Remaining cattle (males, adults & all young stock)		141.03	144.03	145.10
Total cattle		**0.75**	**195.00**	**202.00**	**218.00**
Buffaloes	(i) Improved milch	5.0	11.5	14.7	23.9
	(ii) Non-descript	1.8	20.6	22.5	26.9
	(iii) Remaining buffaloes (male, adults & all young stock)		40.9	43.8	49.2
Total buffaloes		**2.1**	**73.00**	**81.00**	**100.00**

3.13 The projected population of cattle and buffaloes for 1995 has been worked out to be 209 and 98.8 million respectively. The projected population of sheep and goats has been calculated on the basis of the cumulative growth rate between 1951 and 1982 and theirpopulation in 1982.The projected population of sheep and goats works out as under:

Category	Projected population (million) in 1985	1990	1995	2000
Sheep	49.32	51.17	53.08	55.06
Goats	96.16	106.81	118.64	131.78

3.14 Based on the above projected population figures and taking the fodder requirement to be 2 and 3 per cent of the body weight, the dry fodder requirement in 1985, 1990, 1995 and 2000 is summarised in Table 14.

Table 14

Fodder (dry matter) requirement in different years

Category of animals	Dry matter requirement (million tonnes) 1985		1990		1995		2000	
	2 p.c.*	3 p.c.	2 p.c.	3 p.c.	2 p.c.	3 p.c.	2 p.c.	3 p.c.
Cattle	383	574	397	595	411	616	428	642
Buffaloe	213	320	236	355	262	393	292	438
Sheep	27	40	28	42	29	43	30	45
Goat	53	79	58	88	65	97	72	108
Total	**684**	**1,013**	**719**	**1,080**	**771**	**1,156**	**822**	**1,233**

*per cent.

3.15 Another basis for the calculation of fodder requirement can be the standard of feeding adopted by the National Commission on Agriculture in the report and given in table 8. On the basis of the standard of feeding adopted by National Commission on Agriculture and the projected population of livestock in 1985, 1990, 1995 and 2000

given earlier, the fodder requirement for the livestock in 1985, 1990, 1995 and 2000 works out as summarised in table 15.

Table 15

Dry and green fodder requirement for livestock

Year	Category of livestock	Requirement of fodder Per year (million tonnes) Green fodder	Dry fodder
1985	Cattle	436	299
	Buffaloes	154	105
	Sheep	—	27
	Goats	—	52
	Total	**590**	**483**
1990	Cattle	465	312
	Buffaloes	175	118
	Sheep	—	28
	Goats	—	58
	Total	**640**	**516**
1995	Cattle	503	326
	Buffaloes	198	134
	Sheep	—	29
	Goats	—	65
	Total	**701**	**554**
2000	Cattle	554	348
	Buffaloes	226	151
	Sheep	—	30
	Goats	—	72
	Total	**780**	**601**

3.16 To make the estimates of fodder requirement presented in table 14 and 15 comparable, the green fodder requirement given in table 15 has been converted into dry matter. The fodder requirement (dry matter) presented in table 15 then becomes 630, 676, 729 and 796 million tonnes in 1985, 1990, 1995 and 2000 respectively. The fodder requirement worked out at the rate of 2 per cent body weight is quite close to the estimates based on the standard of feeding adopted by National Commission on Agriculture and given in table 15. The committee estimates the minimum requirement of fodder for livestock in 1985, 1990, 1995 and 2000 as 630, 676, 729 and 796 million tonnes respectively. It is the minimum requirement for the maintenance and to ensure higher productivity and economic returns from the livestock, the fodder requirement should be taken to be 1013, 1080, 1156 and 1233 million tonnes of dry matter in 1985, 1990, 1995 and 2000 respectively. This fodder requirement when split into dry and green fodder becomes as under:—

Year	Estimated fodder requirement (million tonnes)	
	Dry fodder	Green fodder
1985	780	932
1990	832	992
1995	890	1064
2000	949	1136

3.17 The above estimates of fodder requirement in 2000 are more than those given for the same year by National Commission on Agriculture. The difference may be explained by the fact that on the basis of the livestock population trend during the last decade the increase in livestock population is expected to be more than that expected by National Commission on Agriculture.

IV. FODDER AVAILABILITY

4.1 The estimates of fodder production in the country vary widely. The fodder produced and consumed depends upon the type of livestock, cropping pattern, areas available, climatic and edaphic factors, socio-economic conditions, etc. The cattle and buffaloes are normally fed on the fodder produced on cultivated areas supplemented by grass and grazing and some leaf-fodder. The sheep and goats are normally maintained on grazing supplemented to a small extent by harvested grasses and leaf-fodder. The grazing and harvested grasses constitute the main fodder for donkeys, ponies and mules. The camels normally subsist on leaf-fodder browsed or lopped from shrubs and trees.

Past Estimates of Fodder Availability

4.2 The fodders produced and consumed in the country are normally agricultural crop residues, green fodders raised on agricultural lands, sugarcane tops, weeds from agricultural.....fields and bunds, grasses. grazing and leaf-fodder obtained from trees. In view of the wide variety of fodders used and also in view of inadequate data base with regard to their production and consumption, the estimation of fodder production in the country is not easy. Various attempts have been made to assess the production and availability of fodder in the country.

4.3 The Committee on Livestock Feed and Fodder estimated the availability of fodder in the country as presented in table 16.

4.4 The National Commission on Agriculture (1976) adopted the figure of the committee on Livestock Feeds and Fodders for their estimates for 1973 and attempted estimates of the fodder availability in the country for the year 2000 as given in table 17.

Table 16

Estimates of the availability of fodde

Type of fodder/feed	Availability (million tonnes) 1971-72	1978-79 (targeted)
Dry fodder	198.87	300.54
Green fodder		
(i) Cultivated green fodder	214.50	261.00
(ii) Natural herbage (including weeds)	13.00	
Concentrates	11.05	16.16

Table 17

Projected availability of fodder

Type of fodder/feed	Availability (million tonnes)	
	1973	2000
Dry fodder	207.00*	356.80
Green fodder	214.50	575.00
Concentrates	11.05	77.05

*Excluding hay.

4.5 The figures of availability and requirement of fodder as given in Handbook of Agriculture (1980)† are summarised in table 18.

Table 18

Estimated availability and requirement of fodder

Type of fodder	Availability (million tonnes)	Requirement (million tonnes)
Green fodder	224.08	611.99
Crop residues	231.05	869.79
Concentrates	31.60	95.40

4.6 The estimated availability of feeds and fodder for bovine population in India estimated by Shah and coworkers‡ is summarised in table 19.

Table 19

Estimated availability of feeds and fodders for bovine population.

		Availability (million tonnes)						
	Source	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85
A.	Dry fodder							
	(i) Cereal straws	171.31	174.26	177.29	180.43	183.66	187.00	190.46
	(ii) Other dry roughages	129.23	131.52	133.81	136.18	138.62	141.14	143.75
B.	Green fodder							
	(i) Cultivated greens	261.40	266.40	271.36	276.71	282.44	288.00	293.93
	(ii) Natural herbage (including weeds)	430.00	430.00	430.00	430.00	430.00	430.00	430.00
C.	(i) Concentrates	16.41	17.17	17.92	18.74	19.53	20.43	21.34
	(ii) By products	4.10	4.29	4.48	4.69	4.89	5.12	5.35
D.	**Total of A**	300.54	305.78	311.10	316.61	322.28	328.14	334.21
	Total of B	691.00	696.40	701.36	706.71	712.44	718.00	723.93
	Total of C	20.51	21.46	22.40	23.43	24.42	25.55	26.69

† Handbook on Agriculture, 1980. Indian Council of Agriculture Research, New Delhi.

‡Shah, T. *et al*. Impact of increased dairy productivity on farmers' use of feedstuffs, Economic and Political Weekly, *XV*(33): 1407-1412.

Current Estimated Availability

Agricultural crop residues

4.7 The residues of different agricultural crops constitute the major source of fodder for livestock in India. They serve as roughage for maintenance and have to be supplemented with green fodders and/or concentrates. The principal agricultural residues used as fodder are the straw of cereals such as wheat, paddy, barley, maize, sorghum, pearl millet, etc., residues of pulses and oil seeds. The production of agricultural residues depends upon the area devoted for and yield of different agricultural crops. Reliable estimates of the production of agricultural residues in the country are not available. Their production can, however, be estimated on the basis of straw : grain ratio of these crops. It is difficult to make any assumption for straw : grain ratios for different crops grown under different conditions. The proportion of residues vary also between high yielding varieties and the indigenous varieties. In the absence of reliable average figure for the country for different crops, the straw : grain ratio obtained from experimental areas can be adopted. Rajapurohit and Vivekanand* examined straw : grain ratios collected by them and also by V.N. Amble** and the National Commission on Agriculture. On the basis of all the relevant information available, they adopted the figures given in column 2 of table 20 and the same have been used by the Committee.

4.8 The production of agricultural crop residues worked out by multiplying grain production of different crops in 1985-86† by straw: grains ratios for these crops is given in table 20.

Table 20

Estimated production of agricultural crop residues

Crop	Straw:grain ratio	Production 1985-86 (million tonnes)	Production of straw (million tonnes)
Wheat	1.5	46.88	70.32
Maize	2.0	6.89	13.78
Rice	1.5	64.15	96.23
Sorghum	3.0	10.12	30.36
Pearl millet	2.0	3.68	7.36
Gram	0.5	4.56	2.28
Other pulses	1.0	12.96	12.96
Ground nut	0.5	5.50	2.75
Total			**236.04**

* Rajpurohit, A.R. and Vivekanand, M. 1981. Bovine feed availability and requirement in India—A district wise analysis, Agricultural Development and Rural Transformation Unit, Institute for Social & Economic Change, Bangalore-72.

Amble, V.N. *et al.* 1965 Milk Production of bovines in India and their feed availability. Indian Jouranl of Veterinary Science and Animal Husbandry. 35:221—33.

All India Final Estimates of Foodgrain crops—1985-86. Directorate of Economics & Statistics, Ministry of Agriculture, New Delhi.

Grass and grazing

4.9 The grass and grazing constitute another important source of fodder in India. The grasses for fodder are cultivated on a negligible scale and most of the grass is obtained from natural grasslands occurring in forest areas, unculturable lands, other uncultivated land (permanent pasture and grazing land, land under miscellaneous tree crops and groves, culturable waste-lands) and fallow land other than current fallows. On the basis of Land Use Statistics, 1980-81,* the area available for grass production in the country is estimated to be as summarised in table 21.

Table 21

Estimated area under grass production

Type of areas	Million ha
Forest**	74.78
Barren and unculturable land	20.17
Other uncultivated land (excluding fallow land)	
(i) Permanent pasture and grazing land	12.00
(ii) Land under miscellaneous tree crops and groves	3.49
(iii) Culturable wasteland	16.73
Fallow land other than current fallows.	9.82
Total	**136.99**

4.10 The quantity and quality of the grass produced depends on the type of areas, soil fertility, type of grass, climatic conditions and biotic factors. Broadly eight major types of grasslands are recognized in the country as presented in table 22.

Table 22

Major grasslands types of India

Grassland type	Environment	Distribution
Schima/ Dichanthium	Black soils	Western Andhra Pradesh, Maharashtra, Madhya Pradesh South-west Uttar Pradesh, Karnataka, Tamil Nadu.
Dichanthium/ Cenchrus	Sandy loams	Punjab, Delhi, Rajasthan, Eastern Uttar Pradesh, Gujarat, West Bengal, Bihar, Orissa, North Andhra Pradesh, Eastern Madhya Pradesh, Western Maharashtra, Kerala, Eastern Tamil Nadu.
Phragmites/ Saccharum	Marshy localities	Tarai areas of Uttar Pradesh, Bihar, West Bengal and Assam, swamps of Sunderbuns, Kaveri delta.
Bothriochloa	Paddy tracts and high rainfall belt	Lonavala tract of Maharashtra.
Cymbopogon	Low hills	Low hills of Western Ghats, Western Ghats, Vindhya, Satpura, Aravali, Chhota Nagpur Plateau upto about 1000 m elevation.
Arundinella	High mountains	High hills of Western Ghats, Nilgiris, lower

conti....

* Indian Agriculture in Brief 1985 (20th edition), Directorate of Economics & Statistics, Ministry of Agriculture, New Delhi.

** For Forest area : Development of forestry and forest products, country profile, India, Ministry of Agriculture, 1985, New Delhi.

Pradesh, Uttar Pradesh, West Bengal

Grassland type	Environment	Distribution
		Himalayan region in Himachal Pradesh, Uttar Pradesh, Bihar, West Bengal and Assam upto about 2000 m elevation.
Deycuxia/ Arundinella	Mixed temperature climate	Upper Himalayan region in Himachal Pradesh, Jammu & Kashmir, Uttar Pradesh, West Bengal, Assam.
Deschampsis/ Dey euxia		Alpine and sub-alpine regions of the main Himalayas in Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh, West Bengal.

4.11 Most of the grasslands in the country are very poor, degraded and overgrazed. The productivity of the grasslands in the country is, therefore, very low. It may not be correct to adopt a single figure of production for the grasslands of the entire country as their productivity varies widely. The productivity of grass in the forest areas is generally higher than in other grass producing areas, viz., barren and uncultivated land, permanent pastures and grazing land, culturable wastelands and fallow lands. The production of dry grass is reported to generally *from 0.5 to 6.0 tonnes/ha/year (Dabadghao,* & Shankarnarayan, 1973*). The average grass yield from forest area and other grass producing areas is accordingly taken to be about 3 and 1.5 tonnes per hectare per year. The grass produced in all the forest area, however, is not fully utilised. Based on the accessibility and other considerations, it is estimated that only about 50 per cent of the grass growing in the forest areas is presently utilised. The total utilizable dry grass produced annually in the country is estimated to be about 205 million tonnes.

Agricultural green fodders

4.12 The area under green fodders in the country is estimated to be about *4 per cent of the total cultivated area*. Only 20 per cent of the area devoted to fodder production is reported to be irrigated. Even though the livestock plays an important role in the economy of the farmers, the green fodder production is not receiving the attention it deserves. The area under green fodders is not increasing to meet their increasing demand. The green fodders cultivated are broadly classed as leguminous and nonleguminous. The important leguminous fodder crops are berseem *(Trifolium alexandinum), shaftal (T. resupinetum),* white clover *(T. repens),* red clover *(T. pratense),* crimson clover *(T. incarnatum),* alsika clover *(T. hybridum),* cow pea, lucerne, *guar, kulthi, Phillipsaea,* horse gram etc. Important among the nonleguminous fodder crops are maize, sorghum, pearl millet, *ragi,* oats teosinte, and cultivated grasses.

4.13 Besides the above mentioned conventional green fodders, the tops of sugarcane are also used as green fodder in areas of sugarcane cultivation. The weeds and grasses from the cultivated fields and field bunds also constitute a source of green fodder particularly during monsoon season. In irrigated areas, however, the weeds may be available as fodder throughout the year.

* Dabadghao, P.M. & Shankaranarayan, K.A. 1973. The Grass Cover of India, ICAR, New Delhi.

4.14 The average production of green fodder from irrigated and unirrigated areas is expected to be *about 50 and 25 tonnes per hectare per year respectively (NCA, 1976). The total green fodder production form 4 per cent of the cropped area under fodder production (20 per cent irrigated and 80 per cent rainfed) is thus estimated to be about 208 million tonnes annually*. The annual production of sugarcane tops is estimated to be about 4 million tonnes. The quantity of weeds in cultivated area available will, however, greatly vary depending upon the intensity and standard of agricultural practices followed. It is estimated that about 0.1 tonne of green weeds per hectare per year may be available and the total annual production of weeds may approximately be 14 million tonnes.

Tree-leaf-fodder

4.15 The leaf-fodder from trees constitutes an important source of fodder in many parts of the country and particularly in the hilly and arid areas. The trees produce nutritious fodder for livestock. It is seldom realised that in some parts of our country, probably more animals feed on shrubs and trees than on grass and grass pastures.

4.16 No estimates have ever been made regarding the quantity of leaf-fodder available from forest areas. The leaf-fodder available from forest areas will depend on the type of the forest, the proportion of the fodder trees to the total growing stock, the density of the forests, the practice and intensity of harvesting leaf-fodder, the distance of forest areas from the villages etc. In view of all these factors, it is difficult to accurately estimate the quantity of leaf-fodder which may be available from the forest areas. A rough estimate may, however, be possible on the basis of area and stocking of different forest types. Table 23 summarises the area under different forest types and their occurrence in the country.

Table 23

Area and occurrence of different forest types

Forest Types	Area (million ha)	Occurrence
Tropical wet-evergreen forests	4.5	Assam, West Bengal, Karnataka, Kerala, Andaman & Nicobar Islands.
Tropical semi-evergreen forests.	1.9	Assam, West Bengal, Orissa and Andamans.
Tropical moist deciduous forests	22.6	Karnataka, Orissa, Tamil Nadu, Uttar Pradesh, Madhya Pradesh, Maharashtra, Kerala, Andaman & Nicobar Islands.
Tropical deciduous forests	29.2	Almost all over India.
Littoral and Swamp forests	0.7	Deltas of big rivers.

Forest Types	Area (million ha)	Occurrence
Tropical thorn forests	5.2	Punjab, Haryana, Rajasthan, Upper Gangetic Plains, the Deccan Plateau and lower Peninsular India.
Tropical dry evergreen forests	0.1	East Coast in Tamil Nadu.
Sub-tropical broad leaved (hill forests)	0.3	Lower slopes of the Himalayas in West Bengal, Assam, Meghalaya, Nilgiris, Malabar.
Sub-tropical dry evergreen forests	0.2	Siwaliks and Western Himalayas upto about 1000 m height.
Sub-tropical pine forests	3.7	North-West Himalayas, Manipur and Naga Hills.
Montane west-temperate forests	1.6	Tamil Nadu, Kerala, Eastern Himalayas, West Bengal, Assam, Arunachal Pradesh.
Himalayan moist-temperate forests	2.7	Pine and sub-alpine forests in Himalayas between 1500 m and 3000 m height.
Himalayan dry-temperate forests	0.2	Inner range of Himalaya where SW monsoon is feeble.
Sub-alpine forests Moist alpine scrub dry alpine scrub	1.8	Elevations above 3000 m in the Himalaya.

4.17 Except for the coniferous and alpine forests, all other forests, particularly near the habitations, supply fodder. The dry biomass of foliage production in tropical dry deciduous forests near Varanasi in Uttar Pradesh is reported to be about 4.9 tonnes per hectare per year,(4 7 tonnes tree leaves + 0.2 tonnes shrubs).Assuming that the green fodder will be four times as much as the dry biomass and that only about two per cent of total leaf biomass is utilised as leaf-fodder, the leaf-fodder production may be taken to be 0.4 tonne per hectare per year. Total tree leaf-fodder production from forest areas is thus estimated to be about 24 million tonnes

Expected Fodder Production

4.18 The production of different types of fodders in the country estimated in paras 4.8, 4.11, 4.14 and 4.17 is summarised in Table 24.

Table 24

Estimated fodder production in India

Type of fodder	Estimated production (million tonnes)	
	Dry fodder (air dry)	Green fodder
Agricultural crop residues	236	
Grass	205	
Green fodders:		
(i) Cultivated green fodder		208
(ii) Top feeds including sugarcane tops		4
(iii) Weeds		14
Leaf-fodder from trees		24
Total	**441**	**250**

The fodder production in the country falls very much short of the requirement; the shortage of green fodder is more than that of the dry fodder. In view of the continuing deterioration of the forest area and grasslands, dry fodder production from these sources is likely to decrease while the requirement will increase. The possibility of increasing dry fodder production in the form of agricultural crop residues is also limited. The position with respect to green fodder is expected to be not very much different as there is no likelihood of any increase in the area devoted for green fodder producton. The gap between the demand and supply of fodder will this continue widening if fodder production for livestock is not given the attention it deserves.

Strategy for Meeting Fodder Shortage

In view of the degrading fodder resources outside agriculture and because of the increasing fodder requirement for livestock, urgent and effective steps are necessary to bridge the widening gap between the demand and supply of fodder in the country. The strategy for bridging this gap may include the following:-

(i) Better utilistion of the fodder already produced in the country should be ensured. The grasses are normally harvested in dry condition when the nutrient content decreases appreciably. The grasses should be harvested at the pre-flowering stage and appropriate technology need be developed for making and storage of hay under different climatic conditions. Effective steps are necessary to reduce the wastage of fodder during storage. Considerable wastage of fodder occurs in feeding the stalks of sorghum, pearl millet and maize without chaffing. Measures are necessary to ensure that such fodders are chaffed and properly processed before feeding. The fortification of course fodders low in protein through the treatment with urea and molasses may also be taken up to improve the quality of such coarse fodders. The processing and

fortification of non-conventional feeds such as bagasse can also supplement the fodders produced in the country.

(ii) A very small area under agriculture is devoted for the production of green fodder. As a consequence, there is acute shortage of green fodder for the livestock. The green fodder production from agricultural area should be improved and more agricultural area should be brought under green fodder production.

(iii) *The forest areas near the habitations are being overgrazed and over-exploited* for fodder but the grasses growing in remote forest areas are not fully utilised. The grasses from such forest areas should be harvested, processed, stored and transported to convenient places to establish fodder banks for meeting the requirement of fodder in times of scarcity.

(iv) The productivity of grasslands and pastures in the country is very low and considerable scope exists for improving their productivity. The programme for the improvement of grasslands and pastures through reseeding, introduction of suitable legumes, fertiliser application etc. should be taken up as a time bound programme.

(v) The wastelands available in the country offer a great potential for fodder production. Utilisation of such wastelands through silvi-pastoral techniques deserves priority. The wastelands (village common lands, panchayat lands and revenue lands) near the villages should, on priority, be utilised for fodder production.

V. GRAZING

5.1 With the advent of civilization, the economy was mainly pastoral and it gradually developed to agricultural economy with livestock rearing as a major component. To begin with, extensive areas were available for grazing of the livestock. The livestock was, therefore, reared on areas available outside agriculture. Gradually, as the human population increased, the areas available for grazing of livestock were brought under agriculture. During 1951-81, the areas under agriculture increased by 18.4 per cent. The livestock population increased by 42.53 per cent during the period 1951-82. As a result the grazing pressure increased on the forest areas and overgrazing has been one of the most important factors responsible for the degradation of forests. As a result of continuous grazing, the palatable and nutritive grasses are getting replaced by less palatable and inferior grasses. Extensive areas have been invaded by bushes which are not browsed such as *Lantana, Carissa, Dodonea, Partheneum, Eupatorium* etc. Large areas have consequently gone out of grass production and as a result the pressure of grazing on the remaining forest areas has further increased. Degradation of the pasture lands and other areas used for grazing has led to under-nourised livestock with low productivity. The villagers are consequently forced to keep more livestock to compensate for the decrease in productivity. Such an increase in the livestock results in overgrazing and degradation of the areas used for grazing. It is, thus, vicious circle. Unless adquate and urgent steps are taken to break this vicious circle and to tackle to problem of grazing, the destruction of forests and environmental degradation will continue. The National Forest Poljcy of 1952 contained the following cardinal principal on grazing :—

(i) Continous grazing on the same areas by large herds is destructive to the better strains of grasses and leads to a deterioration of the grass complex. Wherever it is permitted and is in great demands, efforts should be made to introduce rotational grazing, the benefits of which should be explained and demonstrated to the villagers.

(ii) Cheap forest grazing has a demoralising effect and leads to the vicious spiral of reckless increase in the number of cattle, inadequate forest grazing, reduced quality of herds and further increase in the numbers resulting in the fall in quality. Free and indiscriminate forest grazing is, therefore, a serious disservice to cattle breeding The notion that a farmer's wealth must be reckoned in terms of the cattle he owns, regardless quality, is one of the causes of India's uneconomic cattle wealth and must be combated.

(iii) Grazing should not be looked upon primarily *as a source of revenue.* But the simple and obvious way of regulating and controlling grazing, as also improving the quality both of grazing, and cattle themselves, is to institute a reasonable fee for the privilege of grazing.

(iv) Grazing must not be allowed in regeneration areas and young plantations

during such periods as the seedings require for establishment; otherwise they stand in danger of being browsed or trampled upon.

(v) Grazing incidence should be kept at a minimum in protection forests, i.e. those forests whose vegetation must be preserved or created for physical and climatic considerations.

5.2 The National Forest policy states that the experience gained in India and elsewhere points to the imposition of restrictions on sheep grazing in forests, and total exclusion of goats therefrom because the damage caused to forest growth by the browsing of these animals is often irreparable and their admission into forest areas is incompatible with the aims and objects of forest management.

Areas Available for Grazing:-

5.3 The areas available for grazing include the forests, permanent pastures and grazing land, culturable wasteland, fallows other than current fallows, current fallows and agricultural fields after harvesting of the crops. The strips along roads, railway lines and canals are also used for grazing the livestock. The area under major categories of land uses providing grazing is summarzied in table 25.

Table 25

Areas under major categories of land providing grazing

States/Union Territories	Area (million hectares)				
	Forests	Permanent pastures & grazing land	Culturable waste lands	Fallow lands other than current fallows	Miscellaneous trees crops & groves
Andhra Pradesh	6.44	0.93	0.87	1.35	0.27
Assam	3.08	0.18	0.14	0.11	0.26
Bihar	2.93	0.14	0.45	0.94	0.21
Gujarat	1.96	0.85	1.99	0.33	0.004
Haryana	0.15	0.03	0.03	—	—
Himachal Pradesh	2.18	0.98	0.22	0.01	0.04
Jammu & Kashmir	2.10	0.12	0.15	0.008	0.10
Karnataka	3.76	1.35	0.50	0.56	0.34
Kerala	1.13	0.005	0.13	0.03	0.06
Madhya Pradesh	16.24	2.83	1.91	1.09	0.16
Maharashtra	6.67	1.56	0.99	0.80	0.19
Manipur	0.60	—	—	—	0.02
Megahalaya	0.64	0.02	0.46	0.26	0.15
Nagaland	0.29	—	0.05	0.42	0.06
Orissa	6.69	0.56	0.25	0.19	0.42
Punjab	0.21	0.004	0.04	—	0.003
Rajasthan	3.46	1.83	6.42	2.09	0.02
Sikkim	0.28	0.10	0.01	—	0.004
Tamil Nadu	2.25	0.16	0.34	0.46	0.21
Tripura	0.63	—	0.002	0.002	0.09

States/Union Territories	Area (million hectares)				
	Forests	Permanent pastures & grazing land	Culturable waste lands	Fallow lands other than current fallows	Miscellaneous trees crops & groves
Uttar Pradesh	5.08	0.29	1.14	0.72	0.64
West Bengal	1.16	0.004	0.37	0.06	0.16
Union Territories	6.77	0.012	0.26	0.38	0.08
Total	74.72	12.00	16.72	9.81	3.491

Source :

(i) Development of forestry and forest product, Country profile India, Ministry of Agriculture, July 1981.

(ii) Indian Agriculture in Brief : 20th editions : DES & Ag. Ministry of Agriculture, 1985.

5.4 The areas available for grazing have gradually decreased. The forest area lost for various purposes (Statewise) during the period (1951-52 to 1975-76) is presented in table 26.

Table 26

Forest area lost to other uses (1951-52 to 1975-76)

States/U.TS	Forest Area (000 ha) lost on account of					
	River valley projects	Agri-cultural purposes	Const-ruction of roads	Establish-ment of industries	Miscellaneous purposes	Total
Andhra Pradesh	33.9	153.0	—	8.5	6.8	202.2
Assam	19.7	17.6	6.6	2.9	25.8	72.6
Bihar	1.3	48.3	1.1	11.1	5.8	67.6
Gujarat	35.0	21.1	0.3	1.1	102.9	160.4
Haryana	—	—	—	0.1	18.0	18.1
Himachal Pradesh	7.7	12.2	1.2	—	5.7	26.8
Jammu & Kashmir	0.1	0.3	0.2	—	90.2	90.8
Karnataka	81.3	79.5	1.7	1.5	144.4	308.4
Kerala	7.8	94.6	0.2	12.1	74.3	189.0
Madhya Pradesh	69.2	1453.3	0.4	24.8	162.1	1801.8
Maharashtra	13.0	118.8	33.1	7.9	42.7	215.5
Nagaland	—	—	—	2.0	0.1	2.1
Orissa	46.8	8.3	0.8	24.2	29.2	109.3
Punjab	—	0.4	—	—	8.1	8.5
Rajasthan	14.5	33.0	0.3	1.3	36.7	85.8
Sikkim	--Nil or Negligible--					
Tamilnadu	45.6	6.6	0.1	0.3	13.0	65.6
Tripura	7.9	11.2	0.2	Neg.	19.7	39.0
Uttar Pradesh	93.5	83.3	4.6	19.4	20.5	221.8
West Bengal	1.7	313.7	2.6	2.9	3.6	324.5
A & N Islands	—	7.0	0.5	Neg.	3.1	10.6
Arunachal Pradesh	0.1	26.3	0.4	7.1	6.1	40.0
D & N Haveli	—	0.5	—	—	—	0.5
Goa, Daman & Diu	—	17.4	2.7	—	1.0	21.1
	—	—	0.1	—	—	0.1
Total	**479.1**	**2506.9**	**57.1**	**127.2**	**965.4***	**4135.7***

Source : Country Profile India, 1981

* Includes an area of 25.6 thousand ha for which statewise details are not available.

5.5 All the forest areas are not available for grazng because of serious soil erosion, invasion by bushes and weeds which are not browsed and closure of some of the areas for afforestation. The National Commission on Agriculture estimated that 88% of the forest area is open to grazing and only remaining about 12% of the forest area remains closed to grazing for regeneration purposes. The total number of animals, which graze in the forests, increased from 35 million in 1956 to 54 million in 1972.

Intensity of Grazing

5.6 The livestock population in all the States and Union Territories has been continuously increasing while the areas available for grazing have decreased. As a result most of the areas, particularly near the habitations, are overgrazed. The figures presented in table 27 show the intensity of grazing in important states.

Table 27

Livestock population and grazing incidence in forests

State	Total No. of livestock (in thousand	Percentage grazing in forest	Equivalent cow units (in thousand	Total forest area 67-68 (000 ha)	Number of cow units per 100 ha of open areas
Andhra Pradesh	33,060	9.0	2,328	6,405	44
-Assam	8,210	1.3	129	4,573	3
Bihar	27,946	30.5	8,945	3,059	385
Himachal Pradesh	4,703	85.1	3,312	2,158	173
Jammu & Kashmir	4,285	13.6	353	2,108	19
Madhya Pradesh	39,989	15.8	10,131	17,169	65
Maharashtra	26,361	19.9	5,310	6,672	89
Punjab	9,295	3.2	384	197	492
Rajasthan	38,878	7.7	2,947	3,758	93
Tamil Nadu	23,979	5.8	991	2,214	52
Tripura	738	—	793	630	133
Uttar Pradesh	49,099	4.1	1,837	4,282	44
Total	2,70,547	13.0	38,460	53,825	81

Source : Report of the Committee for Review of Rights and Concessions in the forest areas of India, Ministry of Agriculture, Deptt. of Agri. & Coopn., Forest Division, March 1984.

5.7 In hilly areas and in areas having extensive forests, the villagers maintain large number of livestock. The intensity of grazing in the hilly areas is consequently very high. Table 28 presents the intensity of grazing in U.P. hill areas.

Table 28

Grazing incidence in U.P. Himalayas

Districts	Total available area for grazing (ha)	Total cattle units	Grazing incidence (cattle unit/ha)
Nainital	2,95,000	2,114,000	7.16
Almora	4,88,800	2,985,000	6.10
Pithoragarh	2,37,300	1,608,000	5.98
Chamoli	4,27,500	3,466,000	8.01
Pauri	4,50,600	1,421,000	3,32
Tehri	2,64,300	1,451,000	5,49
UttarKashi	3,81,300	7,52,000	2.00
Dehra-Dun	1.53.600	1,013,000	6.59

Source : Singh V. & S.K. Bhadula (1984), Farmer's Journal, Sept. New Delhi : 36-47

5.8 With the present level of production of grasslands *each hectare can maintain only two units of livestock (1 cattle* ≐ 4 units). It is, thus, evident that almost all the grazing areas are being grazed much beyond their carrying capacity.

Plantation Programme and Grazing

5.9 With the implementation of plantation programme of five million hectare per year, the area available for grazing will reduce further as the plantation areas will have to be closed to grazing. The closure of such areas will increase the pressure of grazing on the remaining areas. In some of the states where large scale plantation programmes have been undertaken, the graziers particulary the migratory ones, are experiencing difficulty as a result of these areas going out of grazing. The closure of the fodder plantations to grazing will be inevitable because in the absence of effective protection such plantations are likely to be destroyed. The plantation areas will be required to be closed to grazing till such time as the seedling planted grow sufficiently tall to be out of browsing damage. The closure of these plantation area to grazing will, no doubt, increase the grass availability from such areas. *Still feeding* will have to be adopted in place of free grazing to harvest and utilise the fodder produced from such plantation areas.

Problem of Migratory Grazing:-

5.10 The graziers are broadly classed as (i) local graziers and (ii) migratory graziers. The local graziers include the villagers who graze the livestock in the areas adjoining their villages. The livestock is generally brought back and herded at night. The migratory grazing is practised both in the hilly as well as in plain areas. In the hills, the migratory graziers move to the alpine pastures during summer months and to lower areas during winter. They normally maintain sheep and goats which can be taken to alpine pastures for grazing. The migratory grazing in other parts of the country is practised to move the livestock from one place to another in search of fodder. In

some cases migration of the livestock takes place *due to water scarcity also.* The migratory grazing has been practised from the times when man took to pastoral husbandry. Large herds of livestock move from one place to another in the same state or from one state to another. Inter-state disputes of migratory graziers are well known.

5.11 Migratory grazing is attended with a number of problem. The livestock population is maintained much in excess of the local fodder resources. With such a large livestock population, the local fodder resources are over-exploited and the livestock is taken from one place to another in search of fodder. The livestock is conseqently underfed and has very low productivity. Much of the energy of the livestock is spent in continously moving and as a consequence the requirement of fodder for body maintenance is higher and the balance left for the production of milk and other products is small. During the movement of the livestock the vegetation on way is destroyed. The migratory sheep and goats while moving between alpine and lower pastures destroy young regeneration *in the forest areas on way*. Various efforts have been made to settle the migratory graziers but with very little success.

Grazing Regulations

5.12 Grazing regulations differ from one state to another. The "Committee for Review of Rights and Concessions in the Forest Areas of India" appointed by the Government of India studied the grazing regulations also the same as summerised by the Committee are reproduced in Annexure-II.

Effects of overgrazing

5.13 The problem of grazing in the country is a complex one and has many attendant ills. With the system of grazing as is obtainable in most parts of the country everyone is tempted to overexploit the common property of grazing land for individual gain. Graziers are interested only in over-exploiting this resource and not for its maintenance and improvement because these areas are normally not permanently allotted to them.

5.14 The grazing is one of the most important factors responsible for the destruction of the vegetative cover, as a result of which and also because of the compaction of the soil due to grazing soil erosion and water run-off increases. Serious soil erosion in the hilly areas and recurrent floods in the plains are, as a consequence, of common knowledge.

5.15 The grazing in the forest areas complicates forest management and makes scientific management difficult. In many areas where selection system should have been the most appropriate system in the interest of environmental conservation and maximization of production, the same cannot be practised because of grazing. The decision with regard to the choice of species is also at times dictated by the *consideration of grazing problem rather than* by the suitability of species for different sites. The species, which are not easily browsed, are selected for planting even if such species may not be the most suitable ones for a particular site. The compaction of soil as a result of grazing affects infilteration rate and the moisture availability and consequently the productivity of the plantations. The regeneration in

the forest areas gets destroyed and the composition and age class distribution is altered. In many areas the forest growth is thinning out and is gradually diminishing.

The growing stock in the forest decreases with an increase in biotic pressure which is reflected through the distance of a particular point from the forest boundary near the village/agricultural fields. The studies conducted in Udaipur Forest Division of Rajasthan* showed that such a decrease in growing stock as is evidenced by the date presented in table 29.

Table 29

Forest growing stock as affected by biotic pressure (distance from forest boundary)

Distance from forest boundary (km)	Number of sample plots	groaing stock (m^3/ha)
<0.25	252	16.80
0.2<0.50	119	27.66
0.50<0.75	83	29.54
0.75<1.00	78	31.84
1.00<1.50	82	32.93
>1.50	65	34.27

5.16 The grazing in the forest areas necessitates effective fencing which is very costly. The fencing constitutes a sizable proportion of the total plantation cost. If the fencing could be avoided, the plantation cost could be considerably reduced and more areas could be forested within the funds available for the purpose.

5.17 Overgrazing results in lowering the productivity of the grasslands and also in reducing the nutritive value of the fodder produced. As a result, the number of such types of livestock as can sustain themselves on such poor fodder, increases. Greater increase in goat population can be explained by the poor roughage available from many of the grazing areas.

5.18 The improvement in the livestock is closely linked with the quality of fodder. The present system of grazing and consequent availability of poor fodder hampers livestock improvement programmes. In many areas where improved livestock was introduced, its productivity could not be maintained at the desired level in the absence of good fodder.

Stall Feeding :

5.19 Free grazing needs to be discouraged and should be replaced by stall feeding. The practice of stall feeding will help in stopping further degradation of our forest areas and wastelands. The practice of stall feeding is also a pre-requisite for undertaking any fodder development programme. Fodder production programme on wasteland

* Singh, V.P. 1981. Effect of biotic interference on forest-A case study in Udaipur Forest Division of Rajasthan. Indian Forester *107* (21) : 693-97.

can be implemented only with the introduction of stall feeding as the area planted for fodder production cannot be allowed to be grazed freely, particularly during the first few years. Higher labour input required for stall feeding is, however, a serious handicap in popularising this practice. The labour input needed for cutting and carrying the fodder for stall feeding will be much higher than that needed in case of free grazing. Further, the low output from poor quality livestock may not be commensurate with higher investment in case of stall feeding. Livestock improvement programme should, therefore, go hand in hand with the programme of stall feeding. The adoption of the practice of stall feeding necessitates distribution of the common grasslands for harvesting the grass amongst the villagers owning the livestock. The practice of stall feeding will also necessitate storage of the fodder and also its processing including chaffing before feeding to the livestock.The general belief amongst the villagers that the livestock should be taken out for exercise in the grazing grounds and stall feeding may adversely affect their health and productivity is also cited as a factor discouraging stall feeding. The adoption of stall feeding will, therefore, necessitate taking up pasture development programmes, apportioning the grasslands amongst individual livestock owners for grass cutting, and improvement of the livestock to ensure higher economic return from higher investment needed for stall feeding. All these programmes should be supported by an effective extension programme to explain to the farmers the advantages of stall feeding and of maintaining better quality livestock through this practice. The practice of stall feeding should constitute the most important component of the whole programme of fodder production from wastelands and livestock improvement.

VI. FODDER PRODUCTION AND UTILIZATION

6.1 Fodder production techniques vary from region to region, place to place and farmer to farmer. An ideal fodder technique is that which provides the maximum out-turn of digestible nutrients per hectare or the maximum livestock products from a unit area. It should also ensure the availability of succulent, palatable and nutritive fodder throughout the year.

Cultivated Fodders

6.2 Green fodders are cultivated on a very small scale. The area under green fodder is estimated to be about *4% of the total croppedareasin the country.* Because of the increasing emphasis on food production, the diversion of more agricultural area for green fodder production appears difficult. The green fodders are generally produced to meet the requirement of livestock during the period in which their cultivation is possible, i.e., the monsoon season under rainfed conditions and throughout the year *under irrigation*. Storage practices, i.e., hay or silage making are normally practised.

6.3 Some of the intensive fodder crop rotations and expected yields are given in the Annexure IV.

Crop Residues

6.4 Straws and agricultural crop residues constitute an important source of fodder in our country. The straws and agricultural residues are obtained as a by-product of the agricultural crops and the production techniques adopted aim at maximising grain production. The introduction of high yielding varieties, which have comparatively higher grain : straw ratio, as compared to indigenous varieties, has adversely affected straw prodcution. The use of combine harvesters in some parts of the country also results in the loss of agricultural crop residues which could otherwise be used as fodder.

6.5 The agricultural crop straws are increasingly being used as cellulosic raw material for the manufacture of straw boards and other products. Their increased use as cellulosic raw material for these purposes is likely to adversely affect their availability for fodder.

6.6 The agricultural crop residues are stored in improvised bins made out of locally available raw materials and cover of with thatch. The dry stalks of sorghum, pearl millet and maize are normally stocked in the open for storage. Improper storage of agricultural crop residues results in wastage and in lowering of the quality of fodder.

6.7 The agricultural crop residues provide only a poor quality of fodder. These are at times supplemented by green fodder or concentrates. The practice of fortification with molasses or urea is normally not adopted.

Grassland

6.8 The grasses constitute another important source of fodder in the country. The major grassland types met with in the country are given in table 22. *The grasslands are mostly degraded as a result of continuous overgrazing and soil erosion. The soils are consequently shallow, poor in nutrients and severely compacted.* As a result of continuous overgrazing, the proportion of palatable and nutritious grasses has decreased and that of less nutritive and coarse grasses has increased. The productivity of such grasslands is consequently very low as is also the palatability and nutritive value of the grasses growing in such areas. Extensive areas have been invaded by noxious weeds and bushes which yield no fodder and suppress and compete out the grasses. The productive area of pastures has consequently shrunk and the availability of grasses from such areas has decreased.

6.9 The grasslands need to be improved to optimise production. Soil amendment and improvement is necessary. In many areas, particularly in the hills, suitable soil and water conservation measures will be required. The most important step required in the direction of restoration and improvement of the grasslands is the *controlled grazing. The grazing in these areas should in no case exceed the carrying capacity.* Some areas may have to be closed to grazing for a few years to improve soil and for reseeding with suitable grasses and legumes which have disappeared as a result of continuous grazing. As the productivity of the indigenous and already existing grasses in these pastures is low, introduction of improved grasses may be necessary. Appropriate techniques for the introduction of improved grasses and legumes in such areas will, however, have to be standardised and adopted as the improved grasses to be introduced are likely to be competed out by the indigenous inferior grasses already growing in such areas. Measures aiming at complete replacement of the indigenous grasses by improved grasses in pasture lands particularly on slopy lands are likely to result in serious soil erosion. The introduction of improved grasses will, therefore, have to be achieved in such a way as to cause as little soil disturbance as possible. Various methods have been tried to replace indigenous inferior grasses by improved high yielding varieties. The techniques will vary with the type of soil, climate and the species of grasses already existing and the ones to be introduced. In order to improve the nutritive value of the fodder obtainable from grasslands, introduction of suitable legumes is also necessary which has always not been successful because of the competition offered by the grasses already established and also in view of the deficiency of nutrients in most of these areas. The suitable grasses and legumes for introduction in pasture lands for different zones are given in Annexure V.

6.10 Optimum time and frequency of grass cutting are also important factors determining the yield and quality of fodder. Optimum time of harvesting the grasses is normally the

pre-flowering stage and the nutritive value decreases as the maturity advances as is evidenced by the data presented in table 29.

Table 29

Mean values of important constituents of grasses during various stages of growth (percentage on dry matter basis)

Constituents	May/June	July/August	September/October
Crude protein	9.08	8.17	5.01
Crude fibre	31.48	35.30	37.09
Calcium	0.58	0.43	0.37
Phosphorus	0.15	0.10	0.08

6.11 The harvesting of grasses at pre-flowering stage without the adoption of proper methods for drying and hay making presents difficulties in areas where pre-flowering stage falls in monsoon season. The harvesting of grass is, therefore, normally done after the monsoon rains cease. The dry grass harvested after seed shedding provides fodder of very low nutritive value and poor digestibility. In some areas the harvesting of grass is delayed to allow the grasses to shed the seed so that the pastures may regenerate. Harvesting of the grass also gets delayed as it is generally taken up after harvesting the agricultural crops. Solution of these problems is necessary in order to ensure optimum grass yield of better quality.

6.12 Continuous grazing or harvesting of the grass results in the removal of considerable quantities of nutrients from the site. There is no practice of fertiliser application in the grasslands. Most of the grasslands are under the control of Government and are used by the villagers for either grazing their livestock or for harvesting the grasses. As the ownership does not vest in individuals, no pasture development measures are normally undertaken. It has been demonstrated through experiments conducted in different parts of the country that the yield and nutritive value of the grasses can be considerably improved through the *application of fertilisers*. On compacted sites and particularly on slopes, suitable methods for fertiliser application will have to be evolved to ensure that the fertilisers do not get washed down before being utilised by the grasses. The application of nitrogenous fertilisers in split doses has consequently been found better in such areas than the application in one single dose. The application of phosphatic fertilisers presents problems and suitable soil working techniques for the purpose will have to be evolved.

6.13 Introduction of suitable legumes has been found to improve the quality and yield of fodder produced.

Production and distribution of seed

6.14 The nonavailability of improved seed of fodder species/varieties is one of the major constraints in grassland development programme. In case of fodder grasses and legumes, herbage is the economic part of the plant and the production of seed, unlike field crops, is not paid attention. Pre-flowering stage is the optimum

harvesting time for most fodder grasses/legumes. Also seed setting in most species of grasses is erratic and low. Due to heavy seed shattering, low viability and fluffiness, production, procurement and processing of grass seed becomes difficult. In the absence of any regular and definite demand, the seed production in bulk is risky and economically not viable. The supply of seed of fodder grasses/legumes is normally in short supply.

6.15 Seed collection and storage need be organized to make available the required quantities of seed of fodder trees, grasses and legumes. A suitable organization may be necessary to handle this work.

6.16 The requirement of seed will depend on the extent and type of areas required to be brought under grasslands for fodder production and also the finances available for the purpose. The seed rate of grasses will vary widely from 2 to 8 kg/ha with the type of areas required to be seeded. The seed rate of fodder legumes will also vary with the type of legumes to be introduced, the proportion of such legumes in the produce to be arrived at and the type of areas required to be tackled. In view of the necessity of introducing legumes in the pasture lands, the requirement of the seed of these species is expected to be substantial. Large quantities of the seed of fodder trees will also be required for undertaking silvipastoral programme on the required scale.

6.17 Various centres for forage production and demonstration established by Government of India are reported to be producing only about 10-15 tonnes of forage seeds. The total availability of good quality seed of fodder grasses and legumes from known sources is very small when compared to the requirement of such seeds. The organizations, which are engaged in producing seed/planting material of fodder and pasture species, are Indian Grassland and Fodder Research Institute, Jhansi, and its centres; Central Arid Zone Research Institute, Jodhpur (Rajasthan); National Dairy Research Institute, Karnal (Haryana); Regional Stations of Forage Production and Demonstration located at Suratgarh (Rajasthan), Hissar (Haryana), Surat (Gujarat), Jammu & Kashmir, Rajendra Nagar Agricultural University, Hyderabad (Andhra Pradesh), Alamadhi, via Redhills (Tamil Nadu) and Kalyani (West Bengal); Fodder Development Officers of different States, State Forest Departments and Forest Development Corporations, National Seed Corporation of India, etc.

6.18 It is necessary to have an appropriate organisation to handle procurement, processing, storage and marketing of the seed of fodder species at national level. The State Governments should also create necessary facilities for production, processing, storage, exchange and distribution of seed of fodder species. An extension and demonstration programme should also be launched in each State to demonstrate the suitability of improved fodder grasses/legumes for different areas.

Silvi-pastoral Practices

6.19 Silvi-pastoral practice ensures higher yield of better quality fodder besides/maintaining the productivity of the site. The trees grown in the silvi-pastoral system provide a sizable quantity of nutritious fodder. The leaf-fodder from some of the trees is almost as nutritious as that of the leguminous fodder crops. The nutritive value of

leaf-fodder of important tree species is presented in Annexure II (Sen *et al*., 1978). Further, *the trees can produce as much, if not more, green fodder per unit area as agricultural fodder crops*. The leaf-fodder production from trees offers another advantage of producing fuelwood as a by-product which will help in meeting the energy requirements of the rural population. The trees tap the lower layers of the soil which will otherwise not be tapped by the grasses and thus ensure better utilization of the site. The leguminous fodder enrich the site through nitrogen fixation. *Leucaena* crop is estimated to fix about 500 kg nitrogen per hectare per year. It has also been observed that the grasses growing under trees remain green for a longer period and the flowering is also delayed. The harvesting of grasses under silvi-pastoral system at the pre-flowering stage may, thus, be possible after the cessation of monsoon rains. Silvi-pastoral practices ensure effective soil and water conservation.

6.20 Except for scattered trees occurring in grasslands, silvi-pastoral practices have not been adopted on a systematic scale in our country. The experiments conducted at the Indian Grassland & Fodder Research Institute, Jhansi, have demonstrated the efficacy of silvi-pastoral practices in maximising fodder production and in optimising fodder quality. The leguminous trees should be preferred for silvi-pastoral systems. Such trees, besides improving soil fertility, provide better quality fodder. Many leguminous trees can withstand frequent loppings which may be required to harvest the fodder. The trees suitable for particular climates will have to be selected for silvi-pastoral practices in different parts of the country are listed in Annexure VI. Within a particular zone trees suitable for different sites have to be selected. The sites under natural grasslands are normally refractory and poor. The trees suitable for different types of refractory sites are included in Annexure VII.

6.21 The spacing of trees for silvi-pastoral practices will have to be decided keeping in view the legumes and grasses to be grown underneath and also the site and climatic conditions. Sufficient information in respect of silvi-pastoral systems for different parts of the country is not available. Suitable grasses capable of growing under shade of trees will have to be selected and introduced. Many of the high yielding varieties of grasses are capable of growing under light shade of trees. The possibility, thus, exists of having an optimum combination of trees, legumes and grasses under silvi-pastoral conditions.

Storage of Fodder

6.22 Except for green fodder crops, which are harvested and fed simultaneously, other types of fodders are normally required to be stored for some period before feeding to the livestock. The storage of fodder presents a number of problems. In view of its bulky nature, the fodder is normally stored in the open. The dry stalks of sorghum, pearl millet and maize are normally stocked in the open for storage. The grass is also stored in the open except in high rain fall and mountainous areas where it is stored on tree tops or on similar improvised structures. There is considerable wastage during storage. Because of the difficulty in storage, the grass in many areas is not harvested

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* Sen, K.C. *et al* 1978. Nutritive values of Indian cattle feeds and the feeding of animals. Indian Council Agriculture Research (ICAR), New Delhi.

even after it has matured and the dry grass is cut as and when needed. This practice results in wastage of fodder and provides very poor quality roughage.

6.23 The green fodders can be stored through either hay or silage making. Such practices are, however, not popular with the villagers. Making of hay or silage requires input both in terms of know-how and finances and the villagers generally lack in both of them. The leaf fodders harvested from trees are normally not stored, except in case of some deciduous trees whose leaf-fodder will be lost if not harvested and stored before the leaf fall. The leaf-fodder harvested from such trees is kept on the lopped trees or in stacks to be used later when no green fodder is normally available.

6.24 The methods of the storage of fodder in our country need improvement and necessary research should be carried out. The technical know-how for the storage of fodders should be made available to the villagers. Necessary physical and financial inputs for hay and silage making should also be provided to them to avoid quantitative and qualitative loss of fodder.

Utilisation of Fodder

6.25 Agricultural crop residues and straws constitute the main bulk of fodder in the country, but these are of very low nutritive value. Supplementation of such fodder with green leguminous fodder or concentrates becomes necessary. The stalks of sorghum, pearl millet and maize are at times fed to the livestock without even chaffing. This practice results in considerable wastage of fodder as the livestock consumes only the leaves and the stalks are generally wasted. The practice of chaffing such fodder should be introduced and the chaffcutters need be popularised for the purpose to encourage better utilization of such fodder.

6.26 There is a wide variety of trees offering good leaf-fodder. Even though many of these trees are known to produce good fodder and are extensively lopped for the purpose, the nutritive value of their leaf-fodder still remains to be investigated. Out of a large number of trees growing in the country, the nutritive value of only a small number has been ascertained. The research work needs, therefore, be stepped up to investigate the nutritive value of such leaf-fodders. Hardly any information is available on the quantity of leaf-fodder obtainable from trees of different species and grown under different management systems. The fodder yield from trees will vary with the species, their growth rate, spacing, site fertility, intensity and frequency of lopping, etc. Investigations are needed on all these aspects to know the potential of trees for fodder production and to plan and execute fodder production programmes.

Transport of Fodder

6.27 The fodder production is generally planned by the farmers according to their requirements and the fodder is not normally transported over long distances except for supply to the cities and to the scarcity areas. The fodder shortage results from the failures of crops in drought prone areas. In western and central parts of the country, which are comparatively more drought prone, fodder shortage is quite common. Large quantities of fodder are consequently required to be arranged and transported to such areas.

6.28 The fodder is not normally chaffed or processed before transport. The grass is at times bailed to render handling and transport easier. Because of the bulky nature, the transport of fodder offers a number of problems.

6.29 The transport used includes bullock and camel carts, truck lorries and trains. No data about the total quantity of fodder transported by different modes are available. Data are also lacking on comparative economics of different modes of transport. The transport of such a bulky material as fodder is, however, costly and the transport cost is at times subsidised by the Government. Proper processing of the fodder may make handling easier and may reduce the transportation costs.

6.30 Sufficient quantities of fodder are always not available for transportation and supply to scarcity areas. The grasses growing in the forest areas are normally harvested by the villagers according to their requirements. From areas. which are away from habitations, the grasses are not harvested and are allowed to go waste. Most of such areas belong to the Forest Department which does not undertake collection and storage of grasses from such areas and it is only in times of scarcity and need that the Forest Department undertakes cutting of grasses from such areas for supply to scarcity areas. It may be advisable to harvest grass from areas where it may be surplus to the requirements of the local villagers and to process and store the same to create fodder banks for supply to needy areas.

VII. FODDER PRODUCTION FROM WASTELANDS

7.1 The fodder production in India is insufficient to meet the fodder requirement of the livestock which is consequently very much underfed. The shortage of fodder in terms of quality is even greater. Possibilities of increasing the production of green fodder under agriculture are very limited. The areas outside agriculture will, therefore, have to be utilized for fodder production. Cultivation of fodder trees offers a great potential to meet the shortage of fodder in the country. Afforestation of wastelands for fodder production thus assumes greater importance. Silvi-pastoral practices combining trees with shrubs and grasses in wastelands afforestation programmes deserve priority. Adoption of suitable silvi-pastoral practices can ensure optimisation of fodder production and also site improvement and environmental conservation.

7.2 By ownership, the wastelands may be classed as (i) Government owned wastelands, (ii) village common/community lands, (iii) lands leased to industries/corporations, and (iv) privately owned lands.

7.3 Wastelands in the ownership of the Government may broadly fall under *degraded forests, permanent pastures* and grazing *lands,* and *culturable wastelands.* These may either be under the control of the Forest Department, Revenue Department of any other Government organisation/department. The department owning the wastelands should undertake afforestation work *for fodder production* on such land with a view to optimise production to meet the requirement of the local people. Out of the total forest area of about 75 million hectares, about *36 million hectares forest area is reported to be degraded.* The area under permanent pastures and grazing lands totals 12.1 million hectares. The States having extensive areas under pastures and grazing lands are Madhya Pradesh (2.8 m ha), Rajasthan (1.8 m ha), Maharashtra (1.5 m ha), Karnataka (1.3 m ha), Himachal Pradesh (1.02 m ha), Andhra Pradesh (0.9 m ha), Gujarat (0.8 m ha) and Orissa (0.5 m ha). All these States have a large livestock population also. It will, therefore, be apropriate to launch a massive programme for the development of permanent pastures and grazing lands for fodder production. The States where *milk cooperatives and fodder development cooperatives* have been formed may be given priority in selecting areas for the development of permanent pastures and grazing lands.

Estimates of Wastelands

7.4 Generally speaking, wastelands are those lands which are presently lying unutilised due to different constraints. Obviously this definition would be incomplete as it would leave out grazing and pasture lands, degraded cultivated lands and degraded forest lands with thin tree cover. Most of the grazing and pasture lands would also have to be classified as wastelands since they are generally degraded. It is common knowledge that such category of lands need the greatest degree of attention although not lying unutilised as such.

7.5 According to another definition, any land should be treated as wasteland if its productivity is less than what it ought to be with reference to the available soil fertility and moisture and climate. This definition is also beset with problems. First, as productivity is a function of the state of technology, the definition would render

estimation and demarcation of wastelands a dynamic and ongoing exercise. Second, to establish cut-off point with regard to the level of productivity of wasteland would be difficult for the purpose of categorisation and therefore such a definition introduced not only an element of subjectivity but the definition bristles with location-specific constraints as well as having practical problems of making uniform and reliable estimates of wastelands a difficult task.

7.6 The National Commission on Agriculture (1976) took a diagnostic view of wastelands, i.e. they tried to estimate such area which was in need of attention and treatment. They estimated the total wastelands area as 175 million hectares, which is 53.3 per cent of the total geographical area in the country of about 329 million hectares and the breakup of wastelands area is given in table 30.

Table 30

Wasteland area estimated by National Commission on Agriculture

	Category	Wastelands (Problem areas) (million hectares)
1.	Cultivable land (including 87 million hectares or eroded cultivated land and permanent pastures)	104.67
2.	Forest land	19.49
3.	Area not cultivable and not under forest	7.91
4.	**Special problem areas**	
	4.1 Gullies and ravines	3.97
	4.2 Alkali soils	7.99
	4.3 Saline soils	7.99
	4.4 Coastal sandy area	7.99
	4.5 Shifting cultivation	4.36
	4.6 Riverine land and torrents	2.73
	4.7 Desert	17.91
	4.8 Waterlogged area	5.99
Total		**175.02**

7.7 The Directorate of Economic and Statistics of the Ministry of Agriculture, Government of India, provides the classification of land use in India as presented in table 31.

Table 31

Land use statistics in 1950 and 1980-81

Category	Area* in million hectares in	
	1950	1980-81
Forest	49	67
Area put to non-agricultural uses	9	18
Barren and unculturable land	38	22
Pasture and grazing lands	7	12
Tree crops and groves	20	3.5
Culturable wastelands	23	17
Fallow land other than current fallows	17	10
Current fallows	11	15
Net area sown	110	140
Total reporting area	**284.4**	**304**

As definitions keep on changing, meaningful comparison is not possible.

7.8 There is no one-to-one correspondence between the categories of the Directorate of Economics & Statistics and the classification of wastelands used by the National Commission on Agriculture. Obviously, wastelands would be in all the categories given in table 32.

7.9 It is generally felt that the estimates of the National Commission on Agriculture are on the high side. According to their report, the total eroded area is 87 million hectares out of a total of 140 million hectares of net area sown. Thus 62 per cent of cultivated area has been classified as wasteland. This area may need treatment as it may be suffering from one or the other type of erosion, but to classify it as wasteland would perhaps not be appropriate

7.10 The Society for Promotion of Wastelands Development have also tried to estimate the total area under wastelands in non-forest area only. The working definition of wastelands suggested by the Society is "those lands are wastelands which are (a) ecologically unstable (b) whose top soil has been nearly completely lost and (c) which have developed toxicity in the root zones for growth of most plants, both annual crops and trees." According to their data the total area under wastelands in non-forest area is 93.7 million hectares. If we add to it 35.9 million hectares identified by the Forest Survey of India (1981-83) as degraded forests, the total comes to 129.58 million hectares. The Statewise breakup is given in table 32.

7.11 On the request of National Wastelands Development Board, the National Remote Sensing Application Centre prepared wasteland maps for the country as well as for each State. The Institute of Coastal and Offshore Research (ICOR), Vishakhapatnam estimated wastelands on the basis of National Remote Sensing Application Centre maps. The total area under wastelands according to ICOR estimates comes to only 55 million hectares as presented in table 33.

7.12 The Institute of Coastal & Offshore Research, Vishakhapatnam, however, qualified their report by adding that these estimates are on the lower side because of the scale of the map used by National Remote Sensing Application Centre, Hyderabad. The meeting organised under the auspices of the National Wasteland Development Board in April 1986, under the Chairmanship of Prof. M.G.K. Menon, Member, Planning Commission, defined wasteland as "that land which is degraded and is presently lying unutilised" (except as current fallow) due to different constraints. Wastelands would consist primarily of (1) Culturable wastelands and (2) Unculturable wastelands. Culturable wastelands would include Gullied and/o ravinous land, Undulating upland, Surface water logged land and marsh, Salt affected land, Shifting cultivation area, Degraded forest land, Degraded non-forest plantation, Sandy area, Mining and industrial wasteland, Strip-lands, Pasture and grazing lands and others. Unculturable wastelands would comprise barren rocky area and steep slopes and snow covered and/or glacial areas.

Table 32

Estimates of wastelands in India

(million ha)

States/U.T.	Area (million ha) of		Total
	Non-forest degraded area*	Forest degraded area**	
Andhra Pradesh	7.86	3.73	11.41
Assam	0.94	0.80	1.74
Bihar	3.90	1.56	5.46
Gujarat	7.15	0.68	7.83
Haryana	2.40	0.07	2.47
Himachal Pradesh	1.42	0.53	1.95
Jammu & Kashmir	0.53	1.03	1.56
Karnataka	7.12	2.04	9.16
Kerala	1.05	0.23	1.28
Madhya Pradesh	12.95	7.20	20.15
Maharashtra	11.56	2.84	14.40
Manipur	0.01	1.42	1.43
Meghalaya	0.82	1.10	1.92
Nagaland	0.51	0.88	1.39
Orissa	3.16	3.23	6.39
Punjab	1.15	0.08	1.23
Rajasthan	18.00	1.93	19.93
Sikkim	0.13	0.15	0.28
Tamil Nadu	3.39	1.01	4.40
Tripura	0.11	0.87	0.98
Uttar Pradesh	6.64	1.43	8.07
West Bengal	2.18	0.36	2.54
UTs	0.89	2.72	3.61
Total	**93.69**	**35.89**	**129.58**

* **Source :** Society for Promotion of Wastelands Developments, New Delhi 1984.
** Baren area notified as forests not included in the above figures.

Table 33

Estimates of wastelands by ICOR

Description	Area (million ha)
Salt affected land	3.99
Gullied or Ravinous Land	6.72
Undulating Upland with or without Scrub	11.74
Jhum or Forest Blank	6.24
Sandy Area	13.94
Barren Hill-Ridge or Rock Outcrop	2.70
Snow Covered or Glacial Area	10.07
Total	**55.40**

Wasteland Development

7.13 The utilisation of wastelands in the country is to be in accordance with the basic objectives of National Landuse Policy which are broadly as under:

(i) To meet the consumption needs of a growing population by increasing productivity of the integrated land resources in the country;

(ii) To prevent any further deterioration of the land resources by appropriate preventive measures;

(iii) To restore the productivty of the degraded land by an appropriate package of practices;

(iv) To provide the necessary technological and extension support to all concerned and to the farming community in particular for obtaining the maximum production through increased productivity;

(v) To allocate land for different uses based upon land capability, land productivity and national production goals;

(vi) To install an efficient and effective administrative structure for prescribing and regulating land use by all concerned including the Government Departments and to revitalise the land use boards in this behalf.

(vii) To involve the community for adoption of appropriate land use for increased productivity by ensuring that the land use policy provides adequately for the consumption and energy needs and generally improves their income levels and provides them a better quality of life;

(viii) To create a greater awareness of the advantages of national land use policies at all levels through appropriate educational, extension and training programme;

(ix) To restructure the livestock production programme in such a manner that the livestock population is gradually limited to economically productive stock and to prevent degradation of grassland by promoting in increasing measures stall feeding of livestock in rural areas;

(x) To provide for optimum use of land which is under agriculture by promoting the concept of mixed-farming systems in which the production programme will include the production of fodder and tree crops also on the marginal and submarginal land of farmers;

(xi) To motivate farmers by organising input supplies and marketing support for encouraging them to cultivate the appropriate crop or fodder or trees in conformity with land use policy;

(xii) To take upon priority basis the completion of land and soil surveys and to complete the inventory of land resources; on the basis of the prescribed land use classification so that resource allocation is based on a reliable data base;

(xiii) To examine the legal support available for enforcement of land use policy in the form of existing State and Central laws and to consider the need for comprehensive legislation to provide some teeth to any machinery entrusted with implementation of national land use policy;

(xiv) To coordinate the formulation and implementation of water resources management policies, forest management policies and urban planning within the overall resource allocation needs dictated by a comprehensive national landuse policy;

(xv) To prepare a plan of action at all levels covering a time-frame relevant to all the objectives specified above and to continuously monitor action taken thereon in an effective fashion.

7.14 The objective Nos **(iii), (v), (ix), (x)** and **(xi)** are relevant to the terms of reference of the committee. According to the basic objectives of National Landuse policy, the land should be used according to its land capability class and national production goals. The livestock production programme is required to be restructured in such a manner that the livestock population is gradually limited to economically productive stock and to prevent degradation of grasslands by promoting stall feeding of the livestock. The use of agricultural land is to be optimised by promoting the concept of mixed farming including the production of fodder and tree crops on the marginal and sub-marginal lands of the farmers. The farmers are to be motivated and supplied with necessary inputs to encourage them to grow suitable fodder crops or trees in conformity with land use policy.

Problems of Wastelands

7.15 The utilisation of wastelands for fodder production is not merely a technological issue. It touches upon a large number of socio-economic problems pertaining to utilisation of common lands, nature of communities, their collective orientation towards resources and property, and also effective intervention from Government for managing common resources. These issues are briefly discussed in the following paragraphs.

7.16 Land policy in India is well developed for approximately 160 million hectares of private agricultural holdings. This includes policies pertaining to land conservation, irrigation, soil conservation, land records, credit systems, pricing policies and land reforms. The same is, however, lacking for the uncultivated half of India which includes common lands, revenue lands and degraded forest land. The very classification of such lands into forest lands, Government revenue lands, *puramboke, gochar, shamlat* and *panchayat* lands show that the intention is to described property rights. Such description says nothing about current potential, productivity, responsiveness to investment etc. The classification of wastelands should provide information about the potential and actual production, uses of such property etc.

7.17 Before any strategy of regenerating wastelands for fodder is suggested, three important questions need to be answered. Why is investment in common lands so low? What conditions are necessary to increase the level of investment? What kind of public policies will promote such an investment?

7.18 In the past when human pressure and animal population was low and common lands were fairly productive, no investment was needed. These natural resources generate sufficient additionalities to take care of the local demand. There was no outside market for the products from common lands. All that was required was a certain tacit agreement within the village communities so that individuals abstained from practices which would result in destruction of common property resources. Therefore, despite inequalities within a village, there were always communally shared norms which regulated community resources. The self-sufficient nature of traditional village economy guided the exploitation of such resources through a system of self-control.

7.19 With the continuous growth of economic activities and improvement in communication and marketing infra-structure, the exploitation of community property started at a fast rate and many such areas have degraded beyond recovery.

7.20 Such an investment should be provided by the Government. As output from regeneration of grazing lands is to be consumed within the village, it may not become an economic activity supported by bankable projects. It will remain a welfare activity to be promoted with Government funds just as construction of schools or hospitals.

7.21 There is enough evidence from India and other Third World countries that common lands are regarded as everyone's property and the individuals do not invest anything for its regeneration. There is always a greed for maximising immediate gains from such lands without any investment.

7.22 People's participation is necessary for managing the common lands. Securing peoples participation should, however, not necessarily mean handling over these areas to the panchayats as they may have no funds or management plans. The underlying principle for the management of common lands should be that the produce from such lands will be entirely for local use. This could be the basis of collaboration between Government and users. Such cooperative ventures have already been tried in social forestry schemes in some places. Non-governmental organisations have also relied upon people's involvement. Keeping these experiences in mind it should be possible to undertake a large number of pilot projects throughout the country for intensification of fodder production. As this would mean withdrawing lands temporarily from grazing, the experiment may present some difficulties in areas where grazing pressure is very acute. In areas where agricultural productivity is increasing a greater part of the fodder requirement can be met from agricultural residues and the villages may to that extent agree to the closure of grazing lands for intensive fodder production programmes.

7.23 The question of distribution of the produce should be settled right from the beginning. The produce may be divided equally amongst households without reference to the number of livestock owned by them. As the managerial capacity of the village community improves to resolve conflicts and to manage the common lands these may even be transferred to the village communities. However, subsidies will have to be given to the Panchayats or village communities for proper maintenance as villagers may not agree to levying of grazing fees in such areas.

Fodder Production Techniques on Wastelands

7.24 Most of the areas under wastelands are refractory with shallow and poor soils. These areas suffer from serious soil erosion or salinity/alkalinity, waterlogging or any other problem. The areas near the habitations are severely overgrazed. The soil is consequently very much compacted and deteriorated. Almost all these areas are rain-fed. The technique of fodder production and the choice of species will, therefore, have to be decided in accordance with the soil and climatic conditions. On the basis of the constraints in their afforestation, the wastelands can be grouped in the following categories : Saline/alkaline soils, seriously eroded gullied and ravined lands, waterlogged sites, sand dunes, cold desert, lateritic and laterite soils and

skeletal soils. The fodder tree species suitable for raising on such areas are listed in Annexure VIII.

Afforestation Techniques

7.25 The techniques of raising trees shrubs and grasses for fodder production in wastelands will be determined by the site and climatic conditions and the species selected for the purpose. It will be out of the scope of this report to describe such techniques for different species and different edapho-climatic zones met with in the country. The silvicultural information about the important fodder trees is, however, contained in Annexure IX.

Protection of Plantations

7.26 The protection of fodder plantations from livestock will be very necessary and at the same time difficult. Most of the plantations will have to be raised in areas being used for grazing of the livestock. The protection of the plantations raised is going to be a difficult problem. The area will have to be effectively fenced to keep out livestock. The fencing used normally includes live hedge fencing, trench fencing, trench-cum-live hedge fencing, stonewall fencing, barbed wire fencing, plain wire and bamboo fencing, brush wood fencing etc. The type of fencing to be adopted depends upon the availability and effectiveness of the fencing material. The barbed wire fencing, stone-wall fencing and trench-cum-mound fencing have been found effective and are generally used.

7.27 The fencing is a very costly operation and accounts for sizable proportion of the total cost of planting. It will be advisable to avoid such costly fencing, if possible. The experience has shown that even such costly fencing does not prove effective in protecting the plantations if the local people are not taken into confidence and their cooperation is not available. It will always be desirable to involve the local population in raising such plantations so that the expenditure and labour involved in providing such fencing may be avoided. The most effective way of protecting such plantations will be to convince the local population of the benefits of such plantations and to ensure their active participation in this programme so that they do not allow their livestock to damage the plantations raised. Such fencing is often termed as social fencing and has proved to be effective in some areas.

VIII. RECOMMENDATIONS

General

8.1 The livestock population in India is very large and the fodder production falls very much short of the fodder requirement. The livestock consequently suffers from undernourishment and malnutrition. The fodder production needs to be considerably increased both quantitatively and qualitatively to ensure better economic returns from the livestock and also to prevent environmental degradation resulting from the destruction of forest growth due to grazing. Extensive wastelands available in the country offer a great potential for increasing fodder production. Various measures will be necessary to optimise production of fodder from wastelands and to ensure its optimal utilisation. In this context, the committee makes the following recommendations:

Livestock Population

8.2 The livestock population of the country is very large and is much more than what can be supported on the existing fodder resources. Most of the livestock population is of poor quality giving very low economic returns to the owner. Effective steps should be taken to check the increase in livestock population and to improve the quality of the livestock. The measures to be taken to check an increase in livestock population may include effective extension programme to convince the farmers about maintaining fewer animals of better quality, to reduce the number of poor quality livestock and to undertake castration of poor quality bulls. A scheme of the exchange of 5 scrub cattle with one crossbred cow may be taken up and gosadans may be established/strengthened to keep the scrub cattle received in exchange.

8.3 The general belief that the religious sentiments in favour of cows are responsible for large population of livestock in the country is not supported by the trend of increase in livestock population. The population of goats, sheep and buffalo increased at a faster rate than that of cattle during 1972-82 decade. The population of sheep and goats has increased sharply during this decade. The goats and sheep and particularly the former destroy vegetative cover and cause environmental degradation. Their population needs to be curbed and reduced. Special efforts should be made to reduce the population of goats particularly in ecologically fragile hilly areas.

8.4 *The density of livestock population per hectare of cropped area* is very high and the livestock population cannot be sustained on cropped area alone. The villagers are tempted to maintain large livestock population to harvest the fodder obtainable from common lands and Government lands outside agriculture and this practice leads to destruction of forest cover and environmental degradation. The fodder production on agricultural lands needs to be encouraged and the farmers should be educated/persuaded to limit the livestock population which can be maintained on fodder to be produced from agricultural area.

Fodder Requirement and Availability

8.5 Accurate estimates of fodder requirement in the country are not available. The requirement of fodder for the livestock should be more accurately and periodically assessed both in quantitative and qualitative terms. The assessment of fodder requirement should also be made for different states and regions to enable proper planning and execution of fodder development programme.

8.6 Reliable estimates of *fodder production* in the country are also not available. The fodder production in the country as estimated by the committee is about 441 million tonnes of dry fodder and about 250 million tonnes of green fodder. Fodder production in the country needs to be more accurately and periodically assessed for different States and regions.

8.7 The fodder produced in the country is not sufficient to meet the fodder requirement of the livestock population. The livestock consequently suffers from underfeeding and malnutrition. The gap between the demand and supply of fodder will widen further because of the decreasing productivity of grasslands and forest areas and as a result of the continuing increase in livestock population. Efforts need, therefore, be made to increase fodder production and also to improve its quality in order to meet the shortages both in terms of quantity and quality. The strategy to meet the shortage of fodder may include better utilisation of the fodders produced, increasing the area under and improving the yield of green fodders, utilisation of grasses growing in remote forest areas and not harvested at present, improvement of grass lands through reseeding, introduction of legumes, fertiliser application etc. and utilisation of wastelands, particularly in the vicinity of the villages, for fodder production.

Grazing and Grasslands

8.8. To supplement the fodder produced from agriculture, the grazing lands in and outside the forest areas are being continuously over-grazed and many of them are very much degraded leading to serious soil erosion and soil impoverishment. The grazing intensity is far more in excess of the carrying capacity in most of these areas. Free grazing as is being practised at present needs to be discouraged and the grazing intensity should be kept within the carrying capacity of an area.

8.9 The areas available for grazing of livestock are continuously shrinking because of the extension of agriculture, increase in soil erosion and invasion by bushes and weeds. As a result, the pressure of grazing on the remaining areas is increasing and such areas are getting damaged very rapidly. Effective measures need, therefore, be taken to prevent encroachment on grasslands and pastures for agriculture and to prevent soil erosion and occupation of these areas by noxious bushes and weeds of no fodder value.

8.10 To ensure that the closure of areas for afforestation does not reduce the fodder production, the fodder production from grasses in such areas should receive greater attention. The afforestation techniques and choice of species should be such as to optimise grass production from these areas. The grasses produced in such areas should, however, not be allowed to be grazed but should be cut and carried for stall feeding of the livestock.

8.11 A sizable proportion of the livestock in the country is migratory moving from one part of the State to another or from one State to another State or from lower hilly areas to alpine pastures and back. The migratory livestock population does serious damage to vegetation. Effective steps may be taken to restrict the migration of cattle within or outside the State as far as possible. Fodder development programmes need to be taken up to produce sufficient fodder for the livestock in a region to avoid migration. Arrangement for water should also be made to prevent migration.

8.12 Continuous overgrazing is one of the most important factors responsible for the destruction of forest vegetation in the country. Free grazing needs, therefore, be discouraged and instead stall feeding of the livestock should be encouraged. Organised support for marketing the milk will, however, be needed to provide incentive to the farmers to undertake livestock improvement and stall feeding. Necessary fodder development programme should be taken up to produce fodder as near to the centres of consumption as possible because higher labour input in case of stall feeding is a major deterent in the adoption of stall feeding. Livestock improvement programmes should also be taken up in such selected areas to ensure better economic returns from higher investments needed for stall feeding.

8.13 Green fodder is produced on agricultural lands on a very small scale. Green fodder production is being neglected because of increasing emphasis on food production. Dry fodder fed to the livestock is of poor quality. Green fodder production needs to be encouraged.

8.14 Agricultural crop residues constitute an important source of fodder in the country. Their availability for use as fodder may decrease because of their diversion for other uses. Steps to prevent their diversion for uses other than fodder, to reduce wastage and to improve quality are necessary.

8.15 Except during the monsoon season, the grasses harvested and fed to the livestock are generally dry and of poor nutritive value. Harvesting of the grasses at pre-flowering stage provides fodder of better quality. The storage of the grass harvested in green condition, however, offers difficulties during storage. The techniques of hay making should be standardised for different climatic conditions and popularised.

8.16 The grasslands are generally very much degraded and generally have very shallow and poor soils. Continuous grazing has resulted in the preponderance of grasses with low productivity and nutritive value. Considerable scope exists to improve the productivity of these grasslands through better management practices, i.e., fertiliser application, optimum time of harvesting, introduction of better grasses and legumes etc. Pasture development should be taken up on priority and as a time bound programme to improve fodder production from grasslands.

8.17 Nonavailability of the seeds of fodder grasses and legumes is one of the biggest constraints in undertaking pasture improvement and fodder development programmes. Production of the seed of fodder grasses and legumes and also of fodder trees should be taken up. Seed production areas may be maintained/ established for the purpose in different agroclimatic zones. The Forest Development Corporation, National Dairy Development Board, institutions/farms of ICAR, Agricultural Universities and Agriculture and Animal Husbandry Department of the

States/Union Territories should be entrusted with the responsibility of the establishment and maintenance of such seed production areas and for the production, processing, storage and supply of the seeds of fodder grasses, legumes and fodder trees. To ensure the quality of the seed an appropriate organisation to handle procurement and marketing of seed of these species should be established at the national level.

Fodder Production and Utilisation

8.18 Appreciable loss of fodder occurs during storage. Effective and economical methods of storage need be evolved and demonstrated to the villagers.

8.19 Some of the fodders particularly the dry stalks of maize, shorghum and pearl millet are not even chaffed for feeding them to the livestock. Such a practice results in considerable wastage of such fodders. The practice of chaffing needs be demonstrated and popularised. Suitable incentives should be considered by the Government for introduction of chaff-cutters.

8.20 The fodder is at times transported over long distances especially to meet the requirement in scarcity areas. Because of the bulky nature of the fodder the transport cost is high. Proper processing and bailing of the fodder should be done to reduce the transportation costs.

Fodder Production on Wastelands

8.21 In view of the shortage of fodder in the country and of the potential of wastelands for fodder production, wasteland development for fodder production deserves high priority.

8.22 While selecting the wastelands for fodder production programme the wastelands under private ownership including sub-marginal agricultural lands should receive priority followed by community/village common lands, revenue lands and undemarcated degraded forest. Demonstration areas should be established to convince the farmers that fodder production through silvi-pastoral practice will be better than conventional agriculture on degraded sub-marginal land.

8.23 Silvi-pastoral system should be adopted for fodder production on wastelands which are otherwise suitable for afforestation. As the tree, grass and legume species for different sites and climatic conditions will vary, trials should be conducted extensively under different edapho-climatic conditions to determine the most suitable species of fodder trees, grasses and legumes. Demonstration plots should be established under different edapho-climatic conditions to demonstrate the suitability of silvi-pastoral systems for fodder production from wastelands.

8.24 The selection of fodder trees, grasses and fodder legumes for wasteland afforestation will have to be according to the land capability class of the wasteland. In case of highly degraded areas where establishment of trees may be difficult and costly, seeding with grasses and fodder legumes may be done as a first step to improve the site.

8.25 Whereas the scope exists for the utilisation of wastelands for fodder production in all the States, it may be better to make a start in the State and areas where milk cooperatives or tree farmers cooperatives have been established in order to ensure better utilisation of the fodder produced.

8.26 For fodder development programme on wastelands under private ownership the owners should be motivated and provided with necessary technical know-how finances and seed/planting material.

8.27 The fencing of the fodder plantation areas will be necessary, but very costly. Efforts should be made to secure social fencing of such plantations through peoples participation.

Research and Development

8.28 Intensive research is needed in the following areas:

(i) Studies on species-site relationships to identify the species of fodder trees, shrubs, legumes and grasses best suited for different sites,

(ii) Investigations on seed collection and storage, seed viability and nursery and plantation technology of fodder trees, shrubs, legumes and grasses,

(iii) Studies on optimum combinations of different species of trees, shrubs and grasses for silvi-pastoral systems under different edapho-climatic conditions,

(iv) Effect of the frequency and intensity of lopping for fodder on the growth of trees and on the productivity of undergrowing fodder shrubs and grasses,

(v) Fodder yield as affected by choice of species, silvicultural and management practices and site factors including soil fertility,

(vi) Harvesting, processing and storage of fodder,

(vii) Determination of nutritive value of leaf-fodder from trees not yet investigated but lopped for fodder,

(viii) Control of insect pests and diseases in fodder plantations,

(ix) Socio-economic factors related to the growing and management of fodder plantations on common lands,

(x) Studies on the distribution of the produce among the beneficiaries and on the impact of such distribution on socio-economic uplift of the people,

(xi) Studies on peoples behaviour towards such programmes and on peoples participation.

Miscellaneous

8.29 Effective extension programme should be undertaken to educate the people about the advantage of keeping fewer animals of better quality rather than maintaining big herds of livestock of poor quality. Information and technical know-how with regard to the maintenance of livestock and cultivation, harvesting, processing, storage and utilization of fodder should also be given to them. This extension programme may be run through block development department, T.V. programme staff, animal husbandry and agriculture departments, social forestry extension staff, non-governmental organisations, radio, T.V. and press.

8.30 As different State departments, *viz.*, agriculture, animal husbandry, are concerned with fodder production programme, a coordinating agency should be established in each State to coordinate the activities of various departments in fodder production.

8.31 In view of the urgency and importance of fodder production from wastelands to reduce the increasing pressure on forests and to prevent environmental degradation, a time bound programme should be taken up for the utilization of wastelands for fodder production.

ANNEXURE-I

NATIONAL WASTELANDS DEVELOPMENT BOARD, LOK NAYAK BHAVAN, 5TH FLOOR, NEW DELHI

No. 7(2)/85-NWDB

Dated the August 1st 1985.

OFFICE MEMORANDUM

1. The National Wastelands Development Board hereby constitutes a Committee on Fodder and Grasses to study the present gap in supply and demand, future projections, institutional arrangements regarding distribution etc. The composition of the Committee will be as under:-

(1)	Dr. R.V. Singh, President, F.R.I. Dehradun	...	Chairman
(2)	Dr. B.D. Patil, IGFRI, Jhansi	...	Member
(3)	Dr. N.S. Jodha, ICRISAT, Hyderabad	...	Member
(4)	Dr. V.K. Misra, Sr. Project Executive, (Fodder Dev.) N.D.D.B.	...	Member
(5)	Dr. J.S. Patil, Agricultural Instt. Kosbad Hill, Distt. Thane-401703	...	Member
(6)	Dr. K.C. Malhotra, Indian Statistical Instt.,	...	Member
(7)	Representative of CAZRI, Jodhpur	...	Member
(8)	Representative of Animal Husbandry Commissioner, Government of India	...	Member

2. The Committee, in its discretion, may coopt any person as a member

3. The terms of reference of the Committee will be a under:-

(1) To assess the present production and availability of fodder and grasses in the country in different seasons;

(2) To estimate the likely requirement of fodder and grasses in the years 1990, 1995 and 2000 A.D;

(3) To estimate the area available for growing fodder under public and private-owned lands;

(4) To study the grazing regulations operating in various States, both for forest and public lands;

(5) To review the situation regarding extent and nature of stall feeding;

(6) To review availability and distribution of fodder seeds, legumes and grasses;

(7) To consider:-

(i) Techniques of growing fodder;
(ii) The species of fodder to be raised; and
(iii) The economics of growing fodder under different agro-climatic conditions.

(8) To draw up a perspective plan for fodder production, harvesting, storage, transport and distribution;

(9) To recommend an integrated action plan for utilising wastelands for fodder and grasses, including fodder trees;

(10) To study any other matter connected with the above.

4. The Committee is requested to submit its report to the Chairman, National Wastelands, Development Board by the 30th November, 1985.

5. Non-official members of the Committee will draw TA/DA as admissible to Grade-I Officers of the Goverment of India for attending the meetings of the Committee and this will be paid by the National Wastelands Development Board.

Sd/-
(N.C. Saxena)
Joint Secretary to the Government of India

ALL MEMBERS

Copy forwarded for information and necessary action to:

1. P.S. to Chairman, N.W.D.B.
2. P.S. to Secretary, (F & WL).
3. Pay & Acctt Officer, Deptt. of Forest & W1., 16 Akbar Road Hutments, New Delhi.

Chemical composition and nutritive value of leaf-fodder from important trees

Name	Chemical composition on DM basis						Digestibility coefficients				Nutritive value on kg/100 kg dry-matter basis**						
	CP	CF	NFE	EE	TA	OM	CP	EE	CE	NFE	No. of tests	CDP	TDN	kg/100 kg raw material	Mcal/kg dry matter DE		Nutritive radio ME
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Acacia catechu	13.0	22.6	51.0	4.6	9.8	—	24	60	31	60	1	2.9	46.3	33.3	2.0	1.7	15.0
Acacia nilotica	11.0	26.7	51.4	3.8	7.1	—	—	—	—	—	—	—	—	—	—	—	—
Adina cordifolia	9.5	14.0	64.0	4.8	7.6	—	28	20	23	67	1	2.7	50.9	42.5	2.2	1.8	18.1
Aegle marmelos	15.1	16.4	52.8	1.5	14.1	—	71	62	30	73	1	10.8	56.7	47.3	2.5	2.1	4.3
Sesbania grandiflora	37.3	6.4	41.0	5.5	9.8	—	—	—	—	—	—	—	—	—	—	—	—
Albizia lebbeck, average	21.7	31.4	36.1	3.7	9.3	—	67	9	41	68	1	11.6	49.3	31.0	2.2	1.8	3.3
Dendrocalamus strictus average	14.6	25.6	43.1	1.6	15.2	—	66	33	58	50	1	9.3	48.9	32.7	2.2	1.8	4.2
Ficus benoghalensis average	9.8	21.9	53.0	2.7	12.5	—	21	29	26	65	1	2.0	44.5	29.0	2.0	1.6	21.4
Madhuca indica	9.5	19.5	60.0	3.9	7.3	—	71	62	30	73	1	0.0	37.0	25.3	1.67	1.3	—
Bauhinia variegata, average	15.7	31.9	40.8	1.8	9.7	—	58	42	64	60	1	9.2	55.5	37.0	2.4	2.0	5.1
Indigefera endecaphylia	8 3	42.2	35.4	1.0	13.1	—	—	—	—	—	—	—	—	—	—	—	—
Careya arborea	10.4	25.9	42.6	7.7	7.5	—	1	18	66	53	1	0.2	43.1	28.0	1.9	1.6	86.2

*Reference

Contd.....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Cordia dichotoma	15.1	16.4	52.8	1.5	14.1	—	71	30	58	76	1	5.1	26.9	12.7	1.2	1.0	4.2
Dalbergia sissoo average	9.6	27.7	48.8	3 2	10.8	—	56	27	30	72	1	9.1	52.2	38.0	2.3	1.9	4.7
Date-palm leaves	11.6	27 7	51 1	1.6	8 0	—	—	—	—	—	—	—	—	—	—	—	—
Diospyros tomentosa	7.1	25.3	56 0	2 2	9.4	—	0	0	28	48	1	0	34.1	19.5	1.5	1.2	—
Ehretia laevis	13.5	18.0	51.2	6.0	11 4	—	62	18	36	73	1	8.4	54.9	44.5	2.4	2.0	5.5
Syzygium cumini	8 8	19 8	62.5	3.1	5 8	—	1	33	70	45	1	0.1	43.8	34.5	1.9	1.6	75.6
Ficus glomerata	11 2	12 3	59.0	2 4	15.1	—	60	48	63	62	1	6.6	53.8	47.0	2.4	2.0	7.0
Ficus lacor (syn.F infectoria)	—	—	—	—	—	—	56	62	32	58	1	5.4	47.1	32.5	2.1	1.7	7.7
Young	11 2	27 7	51.3	2.2	7.7	—	56	53	62	68	1	6.3	62.0	46.0	2.7	2.2	8.9
Mature	12 5	20 0	49.9	3 5	13.1	—	32	24	40	53	1	4.0	40.7	24.0	1.8	1.5	9.2
Autumn	7 3	25.5	50 2	2 7	14.2	—	6	30	33	43	1	0 4	32.2	17.5	1.4	1.2	75.5
Ficus religiosa	9 7	27.0	45 8	2.7	14 9	—	59	36	22	52	1	7 0	38 3	27.7	1.7	1.4	4.5
Ficus sycomorus, average	13.3	20.6	44.9	2.9	18 1	—	—	—	—	—	—	—	—	—	—	—	—
Grewia oppositifolia																	
Maximum	24.9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Minimum	13.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Average	20 2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
July lopped	—	—	—	—	—	—	80	36	54	70	1	16.7	54.6	47.1	2.4	2.0	2.3
September lopped	—	—	—	—	—	—	78	37	47	75	1	15.8	60 2	53.6	2.6	2.2	2.8
Helicteres isora	13.2	19 8	53 0	3 0	10.9	73		23	41	74	1	9.7	58.4	46 8	2.6	2.1	5.0
Heloptelea integrifolia	13.7	—	—	1 9	14.5	—	68	26	—	—	1	5.2	58.1	—	2.6	2 1	10.2

Artocarpus heterophyllus. syn.a. integrifolia Average	12.8	19 9	52.3	2 9	11 7	—	—	—	—	—	—	—	—	—	—	—	—
Kydia calycina	12 5	23.7	46.1	2.3	14 4	—	63	49	47	49	1	7.9	45.2	31.5	2.0	1.6	
Lagerstreomia parfiflora	7.8	17 3	58.2	5 7	11 1	—	11	31	44	64	1	0.9	49.5	39.5	2.2	1.8	56.6
Lannea coromandelica (syn. L.grandis)	11.4	16 1	59 1	4 2	9.2	—	43	62	23	69	1	4.9	55.2	35.0	2.4	2.0	10.3
Leucaena leucocephala (Syn L. glauca)	16.7	12.6	51.1	7 1	12.5	—	—		—	—	—	—	—	—	—	—	——
Mallotus philippinensis	13 4	29.7	44 6	3.6	8 7	—	59	24	31	62	1	7 9	46 6	29.3	2.1	1.7	4.9
Mangifera indica	9 3	23 7	52 6	2 6	11 8	—	—	—	—	—	—	—	—	—	—	—	—
Millettia auriculata	22.7	32.5	30.9	4 6	9.3	—	69	36	32	49	1	15 5	44.9	26.0	2.0	1.6	1.9
Manikara hexandra (syn.) Mimusops hexandra	9.4	23 1	55 0	6.1	7 4	—	—	—	—	—	—	—	—	—	—	—	—
Moringa oleifera (entire leaves)	17.8	9 7	56 8	5.1	10.6	—	—	—	—	—	—	—	—	—	—	—	—
Morinda tinctoria	15.1	22.7	47 8	2.9	11 5	—	—	—	—	—	—	—	—	—	—	—	—
Morus alba	15.0	15 3	48.0	7 4	14 3	—	71	4	54	83	1	10.7	59.6	50 8	2.6.	2.1	4.6
Mytragyma parviflora	7 7	19 6	60.7	3.3	8.7	—	19	0	31	70	1	1.5	49.9	38.5	2.8	1.83	4.7
Oringa oleifera	15.6	17.9	48.7	4.4	13.4	—	71	30	58	76	1	11.1	61.5	50.8	2.7	2.2	4.5
Ougeinia dalbergioides	11.6	26.5	47.6	4 3	10 1	—	32	42	36	62	1	3.7	45.6	30.2	2.0	1.6	11.2
Delonix elata	25 6	7 2	46.5	7 5	13 2	—	—	—	—	—	—	—	—	—	—	—	—
Prosopis spicigera	15.3	17 5	54 1	3.2	10 0	—	—	—	—	—	—	—	—	—	—	—	—
Quercus dilatata	9 6	29 1	51.8	4 5	5.1	—	44	4	25	61	1	4.2	43.2	26.3	1.9	1.6	2.3
Quercus glauca	9.6	29 0	49 6	4.1	7 6	—	48	15	25	54	1	4.6	39.8	23.2	1.8	1.4	7.6

Contd.....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Quercus glauca	9.6	29.0	49.6	4.1	7.6	—	48	15	25	54	1	4.6	39.8	23.2	1.8	1.4	7.6
Quercus incana	10.2	31.3	48.4	4.8	5.2	—	57	29	29	54	1	5.8	43.8	25.8	1.9	1.6	6.6
Saurauia napaulensis	12.2	18.4	51.6	4.2	13.5	—	10	5	35	50	1	1.2	34.0	23.3	1.5	1.2	27.6
Schleichera oleosa	10.4	32.3	49.2	1.9	6.2	—	33	34	31	68	1	13.4	47.5	28.8	2.1	1.7	13.0
Shorea robusta	10.1	27.4	55.4	3.2	3.9	—	11	36	24	58	1	1.1	42.7	27.0	1.9	1.5	38.5
Tamarindus indica	13.4	17.7	52.4	7.0	9.5	—	—	—	—	—	—	—	—	—	—	—	—
Monsoon lopped	11.2	18.7	55.4	5.9	8.8	—	—	—	—	—	—	—	—	—	—	—	—
Winter lopped	12.9	14.2	51 9	8.1	13.1	—	—	—	—	—	—	—	—	—	—	—	
Summer lopped	15.2	21.4	48.5	7.2	7.8	—	—	—	—	—	—	—	—	—	—	—	—
Terminalia bellirica	8.6	18.6	60.1	4.7	8.0	—	10	22	56	66	1	0.9	54.5	43.3	2.4	2.0	62.3
Terminalia tomentosa	8.9	21.8	54.1	4.9	10.3	—	0	35	27	47	1	0.0	34.9	22.3	15	1.3	—
Tinospora cordifolia	11.2	17.5	61 2	2.5	7.8	—	—	—	—	—	—	—	—	—	—	—	—
Ziziphus mauritiana, mature	8.6	30 1	48.8	1.7	10.7	—	36	62	27	34	1	3.1	30.6	15.8	1.3	1.1	9.0
Average of all seasons	15 4	14.2	56 7	2.7	10.2	—	—	—	—	—	—	—	—	—	—	—	—
Ziziphus nummularia	11.5	33.8	46.8	6.8	6 2	—	47	28	54	69	1	5.4	51.1	33.0	2.3	1.9	9.5

ANNEXURE III

GRAZING RIGHTS AND CONCESSIONS IN DIFFERENT STATES OF INDIA

Andhra Pradesh

The policy of the Government is to allow free grazing in all forests of the State except in the areas under regeneration. This concession includes grazing in the reserved forests too. There is also no restriction on the number of cattle grazed. However, goat browsing in the forest areas has been prohibited. It would be pertinent to point out that this relaxation of the grazing policy was introduced in 1968 as a measure to meet the situation created by the drought. The relaxation has, however, continued. Prior to 1968 grazing fee was charged.

Migratory cattle are also permitted free grazing in the forest areas including the Reserve Forests. Cattle from as far away as Rajasthan enter the northern part of the State.

Bihar

Grazing has been recognised as a right in the protected forests and concession in the Reserve forest of State. No grazing fee is being realised for grazing, nor is the number of cattle to be grazed restricted. However, regeneration and plantation areas are required to be closed to grazing for a period of 5 years. In regard to grazing by migratory cattle, the problem is almost insignificant.

Himachal Pradesh

Grazing is permitted both to local right holders and concessionists. Local right-holders have the right of grazing any number of cattle in the forest area adjoining their land holding. As a concession, grazing is also allowed to nomadic graziers of the adjoining States both in respect of sheep and buffaloes. The number of animals permitted to graze differs for different areas and changes from time to time. Rightholders are also permitted to lop trees in different lopping regions both for fodder and bedding material for the cattle.

Karnataka

The policy of the State is no permit free and unrestricted grazing in the forest areas including Reserve forests. However, a system of closure is being followed in regeneration areas. In regard to migratory cattle, the incidence of grazing is almost negligible.

Madhya Pradesh

After reorganization in 1956 grazing rules in the State varied from region to region until 1979. In that year, the Government prepared a uniform policy for the entire State; grazing was permitted in forests free or at concessional/commercial rates. Grazing fee was subject to the number of cattle owned per family of agriculturists/agricultural labour. The details are as under:-

(i) In case of 4 cattle units grazing was permitted free of cost.
(ii) Where there are more than 4 units, but up to 8 units, 4 cattle units were permitted free grazing while rest were required to pay grazing fee at concessional rates.
(iii) In case number of cattle units exceeded, 8, 4 units were permitted free grazing. 4 cattle units at concessional rates and the remaining units were permitted grazing at commerical rates.

The above rights and concessions were applicable to cows, bullocks and buffaloes only which were maintained for non-commercial purposes. Where cattle were maintained for commercial purposes, grazing was permitted only at commerical rates.

However, this policy was subsequently revised and now cows, bullocks and buffaloes are permitted free grazing throughout the year. This concession is also available to tens of thousands of migratory cattle from Rajasthan and elsewhere in accordance with a decision of the Supreme Court. Nominal grazing fee has been imposed for sheep, goats, camels, horses, ponies, elephants etc. It may be added that the browsers are permitted to graze in the protected forests only.

Maharashtra

As per the grazing policy implemented with effect from July, 1969, based on grazing settlement, forest areas have been classified on functional basis to fix maximum and minimum grazing incidence viz. one cattle unit for 10 acres in protected forests, one cattle unit for 3 acres in tree forests (this category includes forests producing timber as the main objective of management). Essential cattle, subject to a maximum of 8 cattle units (adult cow or bullock one unit and adult buffalo 2 units) are permitted free grazing in the forests. For the rest of the cattle, exceeding the aforementioned limit, so also non-essential cattle, a grazing fee has been prescribed. However, all animals up to the age of a 6 months are exempt from paying any fee.

Grazing in the forest areas is, however, subject to the carrying capacity of the grazing units. In order to ensure equitable distribution within the permissible limits, villages are required to the listed into each grazing unit. In case of migratory cattle, no fixed policy exists. A system of closure based on silvicultural requirements is also provided for in the forest policy and the closure ranges for a period between 5 to 10 years after the year of plantation or the year of main felling.

Meghalaya

Grazing is allowed except in young plantations. Forest villagers are allowed free grazing, but cattle coming from outside the reserved forests are charged fees.

Rajasthan

Acoording to Vigyapti of 1955 which is applicable to Udaipur, Chittorgarh, Banswara, Kota, Bundi, Barmer, Jhalawar and Tonk forest divisions the following provisions have been laid down for allowing grazing concessions to Adivasis and cultivators:-

(i) Cows and oxen will be exempted from payment of grazing fees.

(ii) 'Adivasis' including 'adivasi' professional graziers will be able to graze their cattle except camels free of charge in areas not closed for grazing. In hilly areas, cultivators and adivasis will continue to graze their animals free of charge in the forest areas where they have been doing so in the past, camels, sheep and goats will be charged at full rates except at places where not charged previously.
(iii) Free grazing of sheep and goats is allowed in open and village forests.
(iv) Professional non-adivasi graziers will be charged at full rates except in areas where free grazing was allowed previously.

Tamil Nadu

Tribals living in and around forest areas have been permitted grazing of cattle free of cost. Others pay grazing fees, as fixed by Government in protected and reserved forest. Grazing is also permitted tin wildlife sancturies on payment of fees at twice the nomal rates. However, there is on restriction on the number of cattle to be grazed.

Uttar Pradesh

In most of the forest areas, right-holders and concessionists are allowed to graze their cattle free while at other places they are charged nominal fees. Professional graziers are charged a separate grazing and lopping fee fixed from time to time.

For the purpose of grazing, areas have been identified in the working plans and a system of closure of plantation and regeneration areas is being followed.

West Bengal

No grazing rights have been admitted in the reserved and protected forests in the State, but local people residing by the forests are allowed concession of grazing their cattle in open blocks at normal rates.

Stratified fodder production potential of the best fodder-crops rotations in various regions

(Based on All-India Coordinated Project for Research on Forage Crops)

Centre	Best 2-3 rotations at various centres	Green fodder yield (q/ha)
Jhansi	Hybrid Napier+cowpea-berseem+sarson	2,863
	Maize+cowpea-M.P. chari-berseem+sarson	1,972
	M.P.chari-turnips-oats	
Hyderabad	Hybrid Napier+cowpea-Hybrid Napier+ cowpea-Hybrid Napier+berseem	1,334
	Maize+cowpea-bajra+cowpea+berseem	1,267
	Madikattujonna+cowpea-jonna (ratoon)+cowpea-berseem	1,098
Anand	Hybrid Napier alone	2,877
	Hybrid Napier+guar-lucerne	2,529
	Maize+cowpea-maize-cowpea-oats-maize+cowpea	1,685
Kalyani	Maize+cowpea-P. pedicellatum-oats	1,308
	Maize+cowpea-rice bean-berseem+sarson	1,115
	Maize+cowpea-jowar+cowpea-oats	884
Kanke	Maize+cowpea-oats-bajra+cowpea	1,026
	Jowar+cowpea-berseem+sarson-maize+cowpea	960
	Bajra+cowpea-berseem+sarson-maize+cowpea	959
Pantnagar	Napier+berseem intercropped and cut at optimum time	2,141
	Napier+berseem intercropped and cut at the same time	1,998
	Napier+lucerne intercropped and cut at the same time	1,960
Jorhat	Hybrid Napier alone	1,442
	Maize+cowpea-mazie-jowar-oats	664
	Guinea alone	607
Hissar	Napier+bajra hybrid intercropped with berseem	2,117
	Napier-bajra hybrid+lucerne	1,760
	Berseem+japan rape-jowar+cowpea-jowar+cowpea	1,705
Coimbatore	Sorghum+cowpea-maize+cowpea-maize+cowpea	1,107
	Maize+cowpea-maize-cowpea-maize+cowpea	1,060
	Guinea grass round the year	935
Palampur	Maize+cowpea-lucerna+oats+sarson	844
	Maize+cowpea-turnip-oats+pea-cowpea	833
	M.P. chari+cowpea-oats+pea-cowpea	782
Jabalpur	Hybrid Napier intercropped with cowpea-berseem and cowpea	1,761
	M.P. chari-cowpea-berseem+sarson-Jowar+cowpea	1,686

ANNEXURE V

Suitable grasses and legumes for different climatic zone/sites

A. Grasses

Moist Tropical:

Brachiaria mutica, Echinochloa colonum, Euchlaena mexicana, Panicum maximum, Pennisetum pedicellatum, P. purpureum, Sorghum sudanense

Subtropical:

Cymbopogon colorauts, C. martinii, C, citratus, Sehima nervosum, Themeda triandra, Rhynchelytrum repens, Brachiaria mutica, Cenchrus ciliaris, Chloris gayana, Setaria sphacelata, Cynodon plectostachyus, Dichanthium annulatum, Euchlaena mexicana, Arundinella nepalensis, A. bengalensis, Secale cereale, Bothriochloa bladhii, B. odorata, Eulaliopsis binata, Paspalum dilatatum, P. notatum, Phalaris tuberosa, P. canariensis, Themeda anathera, Panicum antidotale, Heteropogon contortus, Cymbopogon martinii, C. coloratus, Chrysopogon aciculatus, C. fulvus, Apluda mufica, Bromus inermis, Dactylis glomerata, Eragrostis curvula, Festuca elaxior, Lolium perenne, L. rigidum, Pennisetum orientale, P. polystachyon, P. hohenackeri, P. pedicellatum, P. clandestinum

Dry Tropical:

Eragrostis lehmanniana, E. tremula, E. curvula, Urochloa pullulans, U. mosambicensis, U. stolonifera, Dichanthium annulatum, Lasiurus sindicus, Panicum turgidum, P. antidotale, Brachiaria ramosa, Cenchrus pennisetiformis, C. biflorus, C. setigerus, C. prieurii, C. ciliaris, Aristida hystrix, Eremopogon foveolatus, Eleusine compressa, Saccharum bengalense, Pennisetum orientale, Tetrapogon villosus, Cymbopogon jwarancusa, sporobolus helvolus, Dactyloctenium sindicum, D. aegyptium, Desmostachya bipinnata

Tropical:
(includes Semi-arid Areas)

Chloris gayana, C. dolichostachya, Cynodon plectostachyus, Dichanthium annulatum, Pennisetum pedicellatum, P. purpureum, Sorghum Sudanense, Urochloa pullulans, U. mosamibicensis, U. stolonifera, Sehima nervosum, Hackelochloa granularis, Cenchrus ciliaris, C. setigerus, Eleusine compressa, Heteropogon contortus, Chrysopogon fulvus, Iseilema laxum, Cymbopogon martinii, Eremopogon foveolatus, Eragrostiella bifaria, Desmostachya bipinnata, Eulaliopsis binata, Saccharum sp. Apluda mutica, Bothriochloa insculpta, B. odorata, B. pertusa, Cynodon dactylon, C. plectostachyus, Eragrostis curvula, E. lehmanniana, E. trichodes, Hyparrhenia rufa, Panicum coloratum, P. repens, P. laevifolium, P. antidotale, P. maximum, Setaria sphacelata, Themeda tremula.

Temperate:

Cocksfoot, *Phalaris tubersa, Agropyron spp.* bromograss *(Bromus inermis), Italianry grass (Lolium multiflorum), Kentucky* blue glass *(Poa pratensis), Orchard* grass *(Dactylis glomerata),* perennial rye grass *(Lolium perenne), Phleum pratense,* tall Oat Grass *(Festuca elatior).*

Black soils:

Chloris bournei C. gayana, Dichanthium annulatum, Bothriochloa pertusa, Cenchrus setigerus, Chrysopogon fulvus, Eragrostis curvula, E. superba, Panicum maximum, P. antidotale, Pennisetum pedicellatum. P. polystachyon, Sehima nervosum.

Laterite and red loam soils:

Pennisetum clandestinum, P. polystachyon, P. pedicellatum, Rhynchelytrum repens, Brachiaria brizantha, Cenchrus ciliaris, Chrysopogon aciculatus, Cynodon plectostachyus, Dichanthium annulatum, D. caricosum, Iseilema laxum, Paspalum dilatatum, P. notatum, Sehima nervosum, Eragrostis curvula, Hyparrhenia rufa, Panicum antidotale, P. coloratum, P. maximum.

Saline & Alkali soils and Coastal sands:

Ischaemum muticum, Latipes senegalensis, Lopholepis, ornithocephala, Stenotaphrum dimidiatum, Thuarea involuta, Zoysia matrella, Myriostachya wightiana, Spinifex littoreus, Polytrias amaura, Sporobolus marginatus, S. helvolus, S. airoides, Dichanthium annulatum, Iseilema prostratum, Cynodon dactylon. Brachiaria mutica, Chloris gayana, C. barbata, C. bournei, C. viragta, Cenchrus ciliaris, Echinochloa colonum, Eleusine compressa, Eriochloa procera, Paspalum scrobiculatum, P. raginatum.

Para grass, Giantstar grass, Sudan grass, Marvol and Natal grass are medium salt tolerant while blue panic, anjan grass, dhaman grass and weeping love grass are low salt tolerant species.

Ravines:

Dichanthium annulatum, Bothriochloa glabra, B. ischaemum, Cenchrus ciliaris.

B. Legumes

Dry tropical:

Dolichos lablab var.*lignosus, Crotalaria burhia, Indigofera cordifolia, I.endecaphylla, I. linifolia, I. hochstetteri, Alysicarpus spp., Tephrosia villosa, T. purpurea, Rhynchosia minima, Clitoria ternatea, Alhagi pseudoalhagi.*

Subtropical:

Centrosema pubescens, Desmodium confrtum, D. triangulare, D. tortuosum, D. uncinatum, D. parviflorum, Pueraria phaseoloides, P. hirsuta, Stylosanthes guayanensis,

S. hamata, Canavalia ensiformis, Dolichos lablab var. lignosus, Lespedeza cuneata, Macroptilum lathyroides, Indigofera endecaphylla, Lotus corniculatus, Medicago sativa, M. polymorpha, Trifolium spp., Clitoria ternatea, Leucaena leucocephala, Stylosanthes gracilis.

Tropical :
(including semi-arid areas):

Alysicarpus rugosus, A. vaginalis, A. monilifer, Atylosia scarabaeoides, Desmodium diffusum, D. curpureum, D. tortuosum, D. uncinatum, Dolichos lablab var. *lignosus, Indigofera endecaphylla, I. hirsuta, I. cordifolia, I. linifolia, Pueraria hirsuta, Phaseolus trilobus, Centrosema pubescens, Clitoria ternatea, Macroptilium lathyroides, Vicia hirsuta, Goniogyna hirta.*

Temperate:

Lucerne or alfalfa strains, Lupines, *Lotus* spp., Medics sweet clovers *(Melilotus* spp.), *Trifolium* spp. (white clover, red clover, subterranean clover etc.).

Black soils:

Aeschynomene indica, A. americana, Alysicarpus rugosus, A. vaginalis, Centrosema pubescens, Clitoria ternatea, Desmodium diffusum, D. laxiflorum, D. uncinatum, D. motorium, Dolichos lablab Var. lignosus, Glycine javanica, Pueraria phaseoloides, Vigna umbellata, V. trilobata, Macroptilium lathyroides, M. atropurpureum, Melilotus alba, Vicia sativa.

Saline and Alkali Areas:

Alysicarpus rugosus,Indigofera linifolia, I. cordifolia, Cassia tora Desmodium triflorum, Vigna umbellata, V. trilobata, Crotalaria spp., Sesbania sesban.

Red Loam and Laterite Soils:

Atylosia sp., Dolichos lablab var *lignosus, Glycine javanica, Indigofera endecaphylla, Pueraria hirsuta.*

List of Fodder Trees for various climatic zones

1. Dry Tropical

Acacia catechu, A. farnesiana, Acacia modesta, A. nilotica, A. senegal, A. tortilis, Adenanthera pavonina, Ailanthus excelsa, Albizia lebbeck, A. procera, Anogeissus pendula, Azardirachta indica, Butea monosperma, Boswellia serrata, Capparis spinosa, Cordia dichotoma, 'C. rothii, Dendrocalamus strictus, Erythrina suberosa, Diospyros melanoxylon, Hardwickia binata, Holoptelea intergrifolia, Leucaena leucocephala, Madhuca longifolia, Mangifera indica, Melia azedarach, Ougeinia ooieinensis Parkinsonia aculeata, Pongamia pinnata, Prosopis chilensis, P. cineraria, Pterocarpus santalinus, Salvadora oleoides, Taamarindus indica, Tecomella undulata, Terminalia crenulata, Ziziphus mauritiana, Bauhinia roxburghiana, B. variegata, Dalbergia sissoo, Gleditsia triacanthos, Samanea saman, Sesbania grandiflora, Cassia siamea.

2. Tropical

Acacia leucophloea, Bauhinia variegata, Careya arborea, Cordia dichotoma, Ficus bengalensis, F. racemosa, F. semicordata, F. religiosa, F. retusa, F. rumphii, Hymenodictyon excelsum, Leucaena leucocephala, Mitragyna parvifolia, Pithecellobium dulce, Schleichera oleosa, Terminalia alata, T. arjuna, T. chebula, T. paniculata, Toona ciliata.

3. Moist Tropical

Acacia catechu, A. nilotica, Adina cordifolia, Aegle marmelos, Ailanthus excelsa, Albizia chinensis, A. lebbeck, A. odoratissima, A. procera, Anogeissus latifolia, Anthocephalus chinensis, Artocarpus chaplasha, A. hirsutus, A. heterophyllus, Azadirachta indica, Bauhinia purpurea, B. roxburghiana, B. variegata, Bombax ceiba, Cassia siamea, Cordia dichotoma, Dalbergia sissoo, Ficus religosa, Garuga pinnata, Gmelina arborea, Holoptelea integrifolia, Kydia calycina, Lagerstroemia parviflora, L. speciosa, Leucaena leucocephala, Mangifera indica, Melia azedarach, Moringa oleifera, Morus alba, Ougeinia oojeinensis, Pterocarpus marsupium, Sesbania grandiflora, Shorea robusta, Syzygium cumini, Terminalia bellirica, T. chebula, T. crenulata, T. myriocarpa, Trema orientalis.

4. Wet Tropical

Adina cordifolia, Aegle marmelos, Albizia amara, A. chinensis, A. odoratissima, A. procera, Artocarpus hirsutus, A. heterophyllus, Syzygium cuminii, Azadirachta indica, Bauhinia purpurea, B. roxburghiana, B. variegata, Ficus spp., Grewia optiva, Kydia calycina, Mangifera indica, Pterocarpus marsupium, P. santalinus, Samanea saman.

5. Sub Tropical

Acacia catechu, Acacia leucophloea, Acer oblongum, Aesculus indica, Alnus nitida, A. nepalensis, Albizia chinensis, Bauhinia malabarica, B. racemosa, B. roxburghiana, B. variegata, Careya arborea, Celtis australis, Cordia dichotoma, Coriaria nepalensis, Cornus oblonga, Dillenia pentagyna, Ehretia laevis, Ficus bengalensis, F. racemosa, F. hispida, F. virens, F. palmata, F. religiosa, F. roxburghiana, Ficus rumphii, Flacourtia indica, Gardenia latifolia, Grewia elastica, G. optiva, G. tiliifolia, Lannea coromandelica, Leucaena leucocephala, Mallotus philippinensis, Manilkara hexandra, Mitragyna parvifolia, Morus laevigata, M. serrata, Quercus leucotrichophora, Soymida febrifuga, Spondias pinnata, Stereospermum suaveolens, Toona ciliata, Trema orientalis, Wrightia tomentosa, Ziziphus xylopyrus.

6. Temperate

Acacia dealbata, A. decurrens, A. meamsii, A. melanoxylon, Aesculus indica, Alnus nitida, A. nepalensis, Cornus captata, Fraxinus excelsa, Grewia optiva, Pistacia integerrima, Celtis australis, Morus serrata, Olea ferruginea, Populus ciliata, Quercus floribunda, Q. glauca, Q. eucotrichophora, Q. semicarpifolia. Robinia pseudacacia, Salix spp., Toona serrat.

ANNEXURE VII

TREES SPECIES SUITABLE FOR DIFFERENT TYPES OF REFRACTORY SITES

Sites	Suitable species
Saline/alkaline Soils	*Acacia nilotica, A. auriculiformis, Azadirachta indica, Prosopis chilensis, P. cineraria, Casuarina equisetifolia, Albizia procera, Tamarix aphylla, Leucaena leucocephala, Eucalyptus* hybrid, *Parkinsonia aculeata* and *Dalbergia sissoo.*
Ravine land	*Acacia catechu, Dalbergia sissoo* (for gully slopes and humps), *Acacia nilotica, Azadirachta indica, Albizia* spp (for saline and alkali patches); *Dendrocalamus strictus, Gmelina arborea* (gully beds); *Eucalyptus* hybrid, *Pongamia pinnata, Ailanthus excelsa, Prosopic chilensis, Leucaena leucocephala, Gliricidia maculata, Bauhinia* spp., *Moringa oleifera, Morus alba, Broussonetia papyrifera.* Grasses which have been found effective for planting on sloped fall are *Cynodon dactylon, C. plectostachyus, Bothriochloa pertusa* and for check dams *Pennisetum purpureum, Panicum antidotale.*
Waterlogged sites	*Eucalyptus robusta, E. tereticornis, Anthocephalus chinensis, Syzygium cumini Salix* spp., *Terminalia arjuna, Acacia nilotica, A. catechu, A. auriculiformis, Barringtonia acutangula, Lagerstroemia speciosa, Dalbergia sissoo, Bombax ceiba, Pongamia pinnata, Trewia nudiflora, Millingtonia hortensis, Taxodium distichum* have been tried with success in beel areas of West Bengal. *Lagerstroemia speciosa* and *Bischofia javanica.*
Sand dunes	*Prosopis chilensis, P. cineraria, Acacia tortilis, A. senegal, A. nilotica, A. aneura, Albizia lebbeck, A. procera, Azadirachta indica, Eucalyptus camaldulensis, Balanites aegyptiaca, Capparis decidua, Salvadora oleoides, Tecomella undulata, Dalbergia sissoo, Tamarix aphylla, Parkinsonia aculeata, Ailanthus excelsa*
Coastal sands	*Casuarina equisetifolia, Anacardium occidentale, Borassus* spp. and *Eucalyptus* spp.

FODDER TREE SPECIES SUITABLE FOR DIFFERENT SITES

Saline/alkaline Soils	*Acacia auriculiformis, A. nilotica, Azadirachta indica, Albizia procera, Leucaena leucocephala, Prosopic cineraria, Parkinsonia aculeata, Dalbergia sissoo.*
Ravina Land	*Acacia catechu, Dalbergia sissoo* (for gully slopes and humps); *Acacia nilotica, Azadirachta indica, Albizia* spp. (for saline and alkali patches); *Dendrocalamus strictus, gmelina arborea* (gully beds); *Pongamia pinnatta, Ailanthus excelsa, Prosopis chilensis, Leucaena leucocephala, Bauhinia* spp., *Moringa oleifera, Morus alba. Grasses: Cynodon dactylon, C. plectostachyus, Bothriochloa pertusa, Pennisetum purpureum, Panicum antidotale.*
Waterlogged sites	*Anthocephalus chinensis, Syzygium cuminii, Salix* spp., *Terminalia arjuna, Barringtonia acutangula, Lagerstroemia speciosa, Dalbergia sissoo, Bombax ceiba, Pongamia pinnata, Trewia nudiflora, Acacia catechu, A. auriculiformis, A. nilotica, Bischofia javanica.*
Sand dunes	(A) *Rainfall zone 15 to 30 cm: Acacia tortilis, Acacia senegal, A. nilotica, Prosopis chilensis, P. cineraria, Ziziphus* spp., *Grasses: Lasiurus sindicus, Cenchrus ciliaris, C. setigerus,* (B) *Railfall Zone 40 cm and above.* *Albizia lebbeck, A. procera, Azadirachta indica, Ailanthus Excelsa, Dalbergia sissoo, Parkinsonia aculeata, Grasses: Cenchrus ciliaris, C. setigerus, Panicum antidotale.*
Cold Desert	*Populus euphratica, P. ciliata, P. alba, Salix fragilis, S. alba.*
Lateritic and Laterite Soils	*Dendrocalamus longispathus, D. strictus, Acacia auriculiformis, Bambusa arundinacea, Madhuea longifolia,*

	Pterocarpus marsupium, Shorea robusta, Bombax ceiba, Adina cordifolia, Schlechera oleosa, Hardwickia binata, Gmelina arborea, Dalbergia sissoo, D. latifolia, Ougeinia oojeinensis, Anogeise latifolia, Holoptelea integrifolia, Albizia lebbeck, Xyda xylocarpa, Tactona grandis, Grass; Eulaliopsis binata.
Skeletal Soils	*Albizia lebbeck, A. amara, Cassa siamea, Hardwickia binata, Prosopis* spp., *Azadirachra indica, Pongamia pinnata, Acacia nilotica ssp. indica, A. leucophloea, A. ferruginea, A. catechu, Dalbergia sissoo, D. latifolia, Tamarindus indica, Ailanthus excelsa.*

SILVICULTURE TECHNIQUE OF SOME FODDER TREES

Sl No	Species	Common Name	Climatic zone	Fruit/seed collection season	No of seed per kg	Seed storage temperature	Seed longevity	Pre-sowing seed treatment	Sowing season	Cermination per cent	Normal germination period in nursery (days)	Optimum spacing in nursery (cm)	Age of normal planting stock (months)	Planting season	Method of planting
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	*Acacia catecha*	Khair	Dtr, Mtr	Jan-March	40,000	RT	MLL	Searification, Hot Water treatment	Mar-	60—80	30	8 x 8	2-3	July	DS. EP ST
2	*Acacia dealbata*	Silver wattle	T	June	86,500	RT	VLL	-do-	Oct.	68	30	10 x 10	6-9	July	DS. EP
3	*Acacia decurrens*	Green wattle	T	Oct.— Nov.	80,357	RT	VLL	-do-	Oct.	50 90	30	10 x 10	9-12	June July	DS, EP. RS
4	*Acacia farnesiana*	Pissi babul	Dtr	July	9,700 12,,100	RT	LL	-do-	May	60-70	30	10 x 10	—	July	DS, EP
5	*Acacia leucophliea*	Sated kikar	ST, TR	April-May	50,000	RT	LL	Not required	June-July	50		20 x 10	12	July-August	EP, DS
6	*Acacia mearnsii*	Black wattle	T	Nov.	95,000	RT	LL	Scarification Hot water treatment	Sept. Oct	57	30	10 x 10	6-9	June-July	DS, EP
7	*Acacia melanoxylon*	Australian black wood	T	July-Nov.	66,000	RT	LL	-do-	Sept. Oct.	60-70	30	10 x 10	-do-	-do-	DS. EP

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
8	*Acacia modesta*	Phulai	Dst, Dtr	Oct-Dec.	21179-35298	RT	LL	Scarification Hot water soaking	Feb-March	60-90	30	10 x 10	6-9	June-July	DS, EP BC
9	*Acacia nilotica*	Babul	Mtr, Dtr	April-June	7000-11000	RT	VLL	-do-	March	88	30	15 x 15	4	-do-	DS, EP
10	*Acacia senegal*	Khor	Dtr	Spring	7,165	RT	LL	-do-	June-July	60-70	30	16 x 15	12	July	DS, EP
11	*Acacia tortilis*	Israeli Kikkar	Dtr	Nov-Feb	12,000	RT	LL	-do-	Feb-March	40-60	60	15 x 15	9	July	EP
12	*Adina cordifolia*	Haldu	Mtr, Wtr	Jan-March	11000000	LR	SL	MLL Not reqired	May	50	30	15 x 10 20 x 10	3	August	DS, EP, ST
13	*Aegle marmelos*	Bal	Mtr, Wtr	March-May	5,300	—	SL	-do-	Soon after collection	56	21	20 x 10	12-24	July	DS, EP
14	*Ailanthus excelsa*	Maharukh	Rtr, Mtr	May-June	9,500	—	SL	-do-	-do-	70-90	45	20 x 10	4-5	July-Aug.	DS, KP, ST, BC
15	*Albizia amara*	Lallei	Dtr F	Feb-April	14,472	RT	VLL	Scarification, Hot water soaking	—	—	—		12	July	DS, EP
16	*Albizia chinensis*	Sirin	Mtr, St	Dec-March	32,143	RT	LL	-do-	Soon after collection	50	7	—	—	—	DS, EP, ST
17	*Albizia lebbeck*	Siris	Dtr, Mtr	Jan-March	8000-13000	RT	VLL	-do-	Feb-July	60-94	60	15 x 15	2-3	July	DS, EP, ST

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
18	*Albizia odoratissima*	Kala Siris	Mtr, Wtr	Jan-Feb.	15,600	LT	VLL	-do-	April	30-45	30	15 x 15	2-3	August	DS, EP, ST
19	*Albizia procera*	Safed Siris	Dst, Mtr Wst, Wtr.	Jan-April	21,786	LT	VLL	-do-	May	80-90	21	10 x 10	1	July	DS, EP, ST
20	*Anogeissus latifolia*	Axlewood (Bakli)	Dst, Mst Mtr	Mar-May	135800	—	—	Soaking in water	April-May	Low	15	15 x 15	—	July	EP
21	*Anogeissus pendula*	Kardhai	Dtr	Dec.—Mar	96,400 (Fruits)	—	—	Not required	June	Very low	15	15 x 15	1	August	EP
22	*Anthocephalus chinensis*	Kadam	Mtr	Jan—Feb. *Aug.—Oct.*	9,32,142 *27,21,400*	—	MLL	—do—	February	Fair	21	20 x 20	4-5	June—July	ST.EP
23	*Artocarpus chaplasha*	Chaplash	Mtr	June—Aug.	2,000	—	VSL	—do—	July-Aug.	80	14	8 x 8	1 or 12	July—Aug.	DS, EP, ST
24	*Artocarpus hirsutus*	Aini	Mtr, Wtr	May—July	1,412	—	SL	—do—	—	60	42	—	—	—	DS, EP
25	*Artocarpus heterophyllus*	Kathal	Mtr, Wtr	—do—	43-50	—	SL	—do—	June-July	75	21	20 x 20	12	July	DS, EP
26	*Azadirachta indica*	Neem	Dtr, Mtr	June-Aug.	3,320	RT	VSL	—do—	July	100	21	15 x 15	12	July	DS, EP RS
27	*Bauhinia malabarica*	Amli	St	April—May	1,100—1,200	RT	LL	—do—	April—May—			25 x 15	12	July—Aug.	EP, DS
28	*Bauhinia purpurea*	Khairwal	Mtr	Jan—May	4,000—5,000	—	MLL	—do—	March—April	80-100	30	15 x 15	—	—	DS, ST, EP

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
29	*Bauhinia semla*	Kandla	St	March-April	1,500	—	—	Not required	April—May	—	—	—	—	July—Aug	DS. EP ST
30	*Bauhinia variogata*	Kachnar	Mtr, St, Tr	May—June	2.800—3,520	—	MILL	—do—	May	95	30	15 x 15	2-3	June—July	DS, ST EP
31	*Bombax ceiba*	Semul	Mtr	Mar—May	21,430—38,500	—	MLL	—do—	May	14-75	25	20 x 20	12	Jan—Feb.	DS. EP ST, BC
32	*Bowellia serrata*	Salai	St	May—June	—	—	—	—	June	—	—	—	12	July—Aug	EP. ST BC
33	*Bridelia retusa*	Kaj	St	Nov—Jan	10.000—17.000	—	—	—do—	March	—	—	—	184	July—Aug.	EP
34	*Buchanania latirolia*	Chiroli	St.	April—June	3.000—5.000	RT	LL	N.R.	July	70		—	—	July-Aug	EP, DS
35	*Butea monosperma*	Dhak	Dtr	May-July	9.850—14790	—	MLL	—do—	May	75-100	15	15 x 15	—	July-Aug	DS, ST EP
36	*Careya arborea*	Ass, Kumbi	St, Tr	June-July	2,800	—	—	—do—	June-July	—		15 x 15	—	June-July	DS
37	*Caltis australia*	Kharik	T. St	Oct -Dec.	—	—	LL	—do—	Oct.—Nov.	60—70	3-4	15 x 15	15	Sept-Oct.	DS, EP
38	*Cordia dichotoma*	Lasura	St, Tr	North India: June—Aug South India: April—May	4,000—7,000	RT	LL	—do—	June-July	—		20 x 20	12	June-July	DS
39	*Dalbergia* sissoo	Shisham	Mtr	Nov—March	53.000	RT	MLL	—do—	March	90-100	15	10 x 10	3-4	July-Aug.	DS, EP RC, BC
40	*Dillemis pentagyna*	Kallai	St.	May-June	43.000—50.000	—	SL	—do—	June-July	—	—	—	—	July-Aug	EP. BC
41	*Diosphros melanoxylon*	Tendu	Dtr	April-June	880—*1410*	—	MLL	Alternate wetting & drying	March-Apr	50-60	90	15x15	—		DS, ST, EP

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
42	*Ehretia laevia*	Chamror	St	March-June	70.000—2.20.000	—		—do—	June-July	—	3m x 3m	—	June—July		DS
43	*Ficus bengalonsis*	Bargad	St, Tr	March-May	850 fruits	Rt	—	—do—	May-June	Low	30 x 30	12	July—Aug		EP BC
44	*fious cunia*	Khiri	Tr	March-June	—	—	—	—	—	—	—	—	July—Aug.		EP, BC
45	*F glomerata*	Gular	St. Tr.	March-June	600 riga	—	—	—do—	May-June	—	30 x 30	12	July—Aug		EP, BC
46	*Ficus hispida*	Kathgular	St. Tr	Ripe at most seasons	—	—	—	—	—	—	—	—	July—Aug.		EP, BC
47	*F. lacor*	Pakar	St	May-June	1200—1500 (fruits)	Rt	—	Not required	June—July	Low	30 x 30	12	June-July		EP, ST BC
48	*Ficus palmata*	Pheru	St	May—Oct	—	—	—	—	—	—	—	—	July—Aug		EP, BC
49	*F. religiosa*	Pipal	St. Tr. Mtr.	April-June	—	Tr	—	—do—	March-April or June-July	—	30 x 30	12	June—July		EP, BC
50	*Ficus retusa*	Barri	St Tr	Dec—March	—	—	—	—	March	—	30 x 20	15	July—Aug.		EP bC
51	*F. roxburghi*	Timla	St	March-May	—	—	—	—do—	March-May	—	30 x 20		June—July		EP, BC
52	*Ficus rumphi*	Pitkhan	St, Tr	March-June	—	—	-	—	—	—	—	15	July—Aug.		EP, BC
53	*Flacourtia indica*	Katai	St	March—July	—	—	—	—	—	—	—	—	July-Aug.		EP, BC
54	*Gardenia latifolia*	Papra	St	Dec.—June	125 (fruits)	—	—	—	April	—	15 x 10	15	July—Aug.		EP ST. DS
55	*Gardenia turgida*	Thanela	St	May-June	—	—	—	—	March-April	High germination with fresh seeds	15 x 20	15	July-Aug.		DS, EP
56	*Garuga pinnata*	Kharpat	Mtr	July-Oct.	4 000—5,000	—	MLL	—	July	44 —	15 x 15	2	Aug.—Sep		DS, EP ST

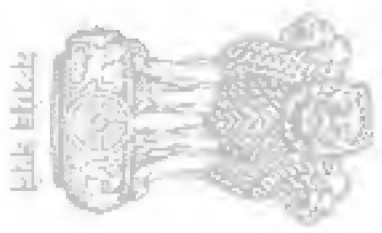
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
57	*Gmevina arborea*	Gamhar	Mtr	May-June	2,500—2,600	RT	MLL	Soakin water	Mar—April	13-85	10-15	15 x 20	1—2	June	DS, EP. ST
58	*Grewia elastica*	Bijal-goch	St	Aug.—Nov	15,000—19,000	—	—	—	March-April	—		15 x 20	4	July—Aug.	EP, ST
59	*Grewia optiva*	Bhimal	St	May-June	12,000-15,000	Rt	LL	Cooling hot water	March	—		20 x 25	12	July-Aug	DS, EP, ST
60	*Grewia tiliaefolia*	Dhaman	St	Sep-Oct	5,000-20,000	Rt	SL	—do—	Feb -March	—		20 x 15	4	July-Aug.	EP, ST
61	*Hardwickia binata*	Anjan	Dtr	April-May	3,900 (fruits)	—	MLL	Not required	April-May	79	28	10 x 10	—	July	DS, EP
62	*Holoptelia integrifolia*	Kanju	Dtr. Mtr	April-May	27,000	—	SL	—do—	Soon after collection	60	10	10 x 10	—	July	DS, EP, SP
63	*Hymeno-dictyon excelsum*	Bartu	Tr	Dec-Feb	1,42,000-1,72,000	RT	MLL	—do—	April-May	30-35	60-120	15 x 15	2	April-May	DS, EP ST
64	*Kydia calycina*	Pula	Mtr	Dec-Mar	32,000	—	MLL	—do—	Soon after collection	13-16	35-45	10 x 10	2-3 or 12	July	DS, EP. ST, TS.
65	*Lager-streemia parviflora*	Lendia	Mtr	Dec-May	28,000	—	MLL	—do—	Feb-Mar	Very poor	28	10 x 10	—	June	EP, ST
66	*Lager-stroemia speciosa*	Jarul	Mtr	Jan-Feb	1,20,000	—	LL	Soak in water	Feb-March	90	10-30	15 x 15	—	June	DS, EP, ST
67	*Lannea coromandelica*	Jhiugan	St	May-June	7,500-9,640	—	VSL	——	May-June	40-60		20 x 25	12	July-Aug	DS, EP, ST
68	*Leusaena leucocephala*	Subabul	St, Mr Tr.	Oct-Nov-May-June	22,000-35,000	RT	LL	Hot water H_2SO_4	Oct	—		22 x 25	9	July-Aug	DS, EP
69	*Madhuca longifolia*	Mahua	Dtr	June-Aug	450	—	SL	Not required	July-Aug	High	15	15 x 15	12	July	DS EP, ST

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
70	*Mallotus philippinensis*	Rohni	St	March-June	23,000-28,000	—	VSL	Cooling boiled water	Mar-April	—		20 x 10	12	July-Aug	DS, EP ST
71	*Mangifera indica*	Mango	Dtr Mtr. Wtr	April-July	10-237	LT	VSL	Soak in water	June-July	High	30	20 x 20	12	July	EP RC
72	*Manilkara hexandra*	Khirni	St	April-June	8,000	—	—	—	April-May	—		—	—	July-Aug	EP, DS
73	*Melia azedarach*	Bakain	Dtr. Mtr	Jan-Feb	750-917	RT (Sealed tin)	LL	Not required	Feb-May	70-80	20-40	15 x 15	12	July	DS, EP ST BC EP
74	*Mitragyna parviflora*	Phaldu	St, Tr.	South India Nov-Dec North India April-May	1,00,000,00	—		—do—	March-April	50-60	—	20 x 10	12	July-Aug	DS, EP ST
75	*Moringa oleifera*	Sanjna	Mtr	April-June	8,000-9,000	—	SL	—	Soon after collection	66	20-30	15 x 15	6	July-Aug	DS BC
76	*Morus alba*	Mulberry (Tut)	Mtr	May-June	4.28,000-4,65,000	—	VLL	Not required	June	70	45	15 x 15	—	July	EP, BC ST
77	*Morua laevigata*	Bola	St	April-June	4.43,000	—	SL	—	Soon after collection	50-80	35	15 x 15	2	Aug-Feb	EP, ST BC
78	*Morus serrata*	Kima	St, T	June-July	—	RT	—	—	June-July	—		30 x 15	12	Jan-Feb	EP, BC
79	*Olea ferruginea*	Indian Olive (Kan)	T	Sept-Dec	9,000	RT	MLL-LL	Acid sorrfication	Sept-Oct	45-65	28	20 x 20	18	July-Aug	DS, EP RS, RC
80	*Ougeunia oogeinensis*	Sandan	Dtr. Mtr.	May-June	28,000-33,000	—	—	Soaking in water	May-June	75	30	15 x 15	—	July-Aug	DS, EP ST, RC
81	*Pithecallobium dulce*	Jangli Jalebi	Tr	April	6,700	—	—	—do—	Feb-March	45	35	15 x 15	5-9	—do—	DS, BC, EP
82	*Pongamia pinnata*	Karnaj	Dtr	Mar-May	800-1,500	—	SL-MLL	—do—	July-Aug	80	30	15 x 20	10-12	June-July	DS, ST, EP

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
83	*Populus ciliata*	Pahari pipal	T	June	1,50,000.00	LT	VSL	N.R.	Soon after collection Cutting: Jan-Feb	70-80		Seeds: sown in trays Cuttings: 50 x 50 cms.	12	Feb-Mar	EP
84	*Prosopis chilensis*	Kikkar	Dtr	May-June	12,500	RT	LL VLL	Soarif-cation soak in water	March	85-95	14	10 x 10	4	July	DS, ST EP
85.	*Prosopis cineraria*	Jand	Dtr	June-Aug	25,000	RT	LL	—do—	June	65	14	10 x 10	12	July	DS, EP
86	*Pterocarpus marsupium*	Bijasal	Mtr	Dec-April	1590-1940 (fruits)	—	MLL	Soak in camphor water	June	40-90	56	10 x 10	4	June-July	DS, EP BP
87	*Pterocarpus santalinus*	Red sanders	Dtr	Feb-April	1,000 (fruits)	—	MLL	Soak in water	May-June	10-80	10 days onwards	20 x 20	12	July	EP, ST
88	*Quercus dilatata*	Moru	T	Sep-Oct	500-600 acorns	RT	L	N.R.	March	—		20 x 10	15	July-Aug.	EP, DS
89	*Q. glancea*	Bani	T	Nov-Dec	570	RT	MLL	—do—	March-April	—		20 x 5	15	July-Aug	EP, DS. AL
90	*PQ. leuco-trichophora*	Bani	T St	Dec-Jan	500-800 acorns	LT	LL	N.R.	Feb-March	60		25 x 10	15	July-Aug	EP, DS AL
91	*Quercus semicarpifolia*	Kharsu	T	July-Aug	140 acorns	—	SL	—	July	95-100		20 x 10	24	July-Aug	EP, DS
92	*Robinia pseudecacia*	Black locust	T	Sep-Oct	30,000-50,000	LT	— —	Scari-rication	April-May	80-90	30	10 x 10	12-24	July	DS. EP
93	*Salix tetrasperma*	Bed	T	March-April	—	—	—	Not required	Soon after collection cutting: Jan-Feb	—		Cutting: 60 x 30	12	January	EP
94	Schleichera *oleosa*	Kosum	Tr	June-July	1,410-2,190	—	VSL	—do—	Soon after collection	58	10-90-	15 x 15	—	July	DS, ST. RS, RC

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
95	Shorea *robusta*	Sal	Mtr	May-June	575-1,000 *(fruits)*	LT	VSL	—do—	—do—	75-90	10-28	20 x 20	12	July-Aug	DS. EP. ST
96	*Soymida febriruga*	Rohini	St	June-Aug	9,000-*12.000*	—	VSL	—	June	—	—	20 x 10	24	July-Aug	EP. DS
97	*Spondias pinnata*	Amra	St	Dec-Feb	290	—	LL	50	June-July			20 x 10	2	Aug	EP. DS. BC
98	*Stereospermum suavellens*	Paral	Mst	Dec-Jan April	27,358	—	SL	Soak in water	Mar-May	45	90	10 x 10	—	–	EP, DS, RS
99	*Syzygium cumini*	Jaman	Mtr	June	1 200	—	VSL	N.R.	Soon after collection	90	30	15 x 15	12	July	DS. EP. ST
100	*Tamarindus indica*	Imli	Dtr	Mar-April	1,800	RT	LL	Soak in hot water	April	66	15-20	15 x 15	24	July	DS. EP
101	*Terminalia alata*	Laurel	Tr	Feb-May	13.000	—	MLL	Soak in water	April	35-70	25	15 x 15	—	July	DS. ST. EP
102	*Terminalia arjuna*	Arjun	Tr	Feb-May	775	—	MLL	—do—	April-May	50-60	50	15 x 15	9	June-July	DS. ST. EP
103	*Terminalia bellirica*	Bahera	Mtr	Nov-Feb	423	RT	MLL	Alternate wetting & drying	March-April	86-100	30-	15 x 15	12	June-July	DS. ST. EP
104	*Terminalia chebula*	H-ara	Mtr, Tr	Jan-Mar Dec-May	141-220 (fruits)	RT	MLL	-do-	June-July	60	90	15x15	12	July	DS, EP
105	*Terminalia crenulata*	Laurel	Mtr, Dtr, *Wst.*	March-April	500 *(fruits)*	RT	SL	—	Soon after collection	70	15-35	18 x 8	2	July	EP. DS
106	*Terminalia myriocarpa*	Hollock	Mtr	Jan-Feb	5 00,000 *(fruits)*	RT	MLL	—	—do—	20-30	28	10 x 10	12	July	DS. EP
107	*Terminalia paniculata*	Kinjal	Tr	Dec-May	350-450 *(fruits)*	RT	SL	Low	—			—	—	—	EP. ST
108	*Toona*	Toon	Tr	April-June	5 50,000	LT	SL	M N R	Soon after collection	60-80	10-15	15 x 15	12	July	DS. EP ST

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
109	*Trema orientalis*	Jiban	Mtr. St	Dec-May	3,60,000	—	—	—	April	—	—	—	3	July	EP DS. TC
110	*Wrightia tomentosa*	Dudhi	St	Jan-April	60,000			—	March-April		—	20 x 10	3	July-Aug	DS. EP
111	*Ziziphus mauritiana*	Bor	Dtr. Mtr	Feb-March	1,240 *1,760*	—	LL	Soak in water	April-May	31-95	16-87	15 x 15	2-3	July	DS. BC, EP
112	*Zizyphus xylopyrus*	Kat-ber	St	Jan-April	—	RT	VLL	—	March-April				12	July	DS. EP



ABBREVIATIONS USED

Abbreviations for Climatic Zone

DSt. : Dry-Subtropical
Dtr : Dry-tropical
MSt : Moist-Subtropical
St : Subtropical
MT : Moist-Temperate
WT : Wet-Temperate
T : Temperate
Mtr : Moist-tropical
Tr : Tropical
Wtr : Wet-tropical

Abbreviations of Seed Viability Period

VSL : Very Short Lived (one month)
SL : Short Lived (1 to 6 months)
MLL : Moderate Long Lived (6 to 12 months)
LL : Long Lived (1 to 2 years)
VLL : Very Long Lived (2 years)

Abbreviations for Seed Storage Method

RT : Room Temperature
LT : Low Temperature (Store in Refrigerator)

Abbreviations for Planting Method

EP : Entire Planting
DS : Direct Sowing
BC : Branch Cutting
ST : Stump Planting
RS : Root Suckers
AL : Air Layering
BS : Budded Stump
R : Rhizome
O : Offset
TS : Tree Stumping
BG : Budded Grafting
RC : Root Cutting

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